INSTRUCTION MANUAL

for

RADIO INTERFERENCE-FIELD INTENSITY MEASURING EQUIPMENT NM-25T

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STODDART NO. 40350

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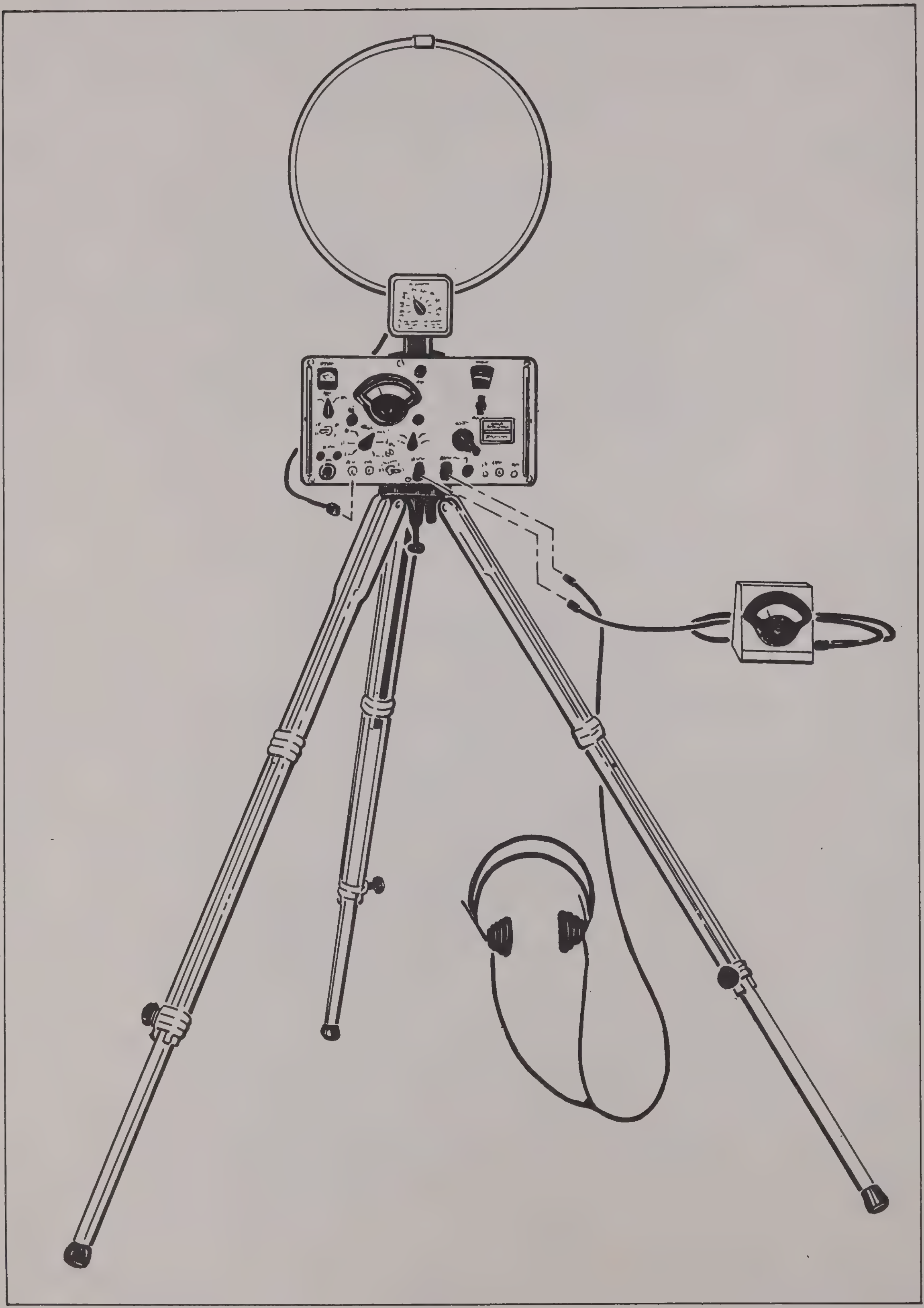

Figure 1-1. STODDART NM-25T RFI Meter in Typical Test Setup

SECTION I

DESCRIPTION AND LEADING PARTICULARS

1.1 INTRODUCTION

This manual contains operation and maintenance instructions for the Model NM-25T Radio Interference and Field Intensity Measuring Set, manufactured by STODDART ELECTRO SYSTEMS, Gardena, California. The manual is divided into six sections; i.e., Description and Leading Particulars, Preparation for Operation, Operating Instructions, Principles of Operation, Maintenance, and a Parts List. Figure 1-1 illustrates the equipment in a typical test setup, while Figure 1-2 illustrates the equipment complete with accessories.

1.2 LEADING PARTICULARS

The STODDART NM-25T Radio Interference and Field Intensity Measuring Set, hereafter referred to as the RFI Meter, is a portable test instrument for measuring and analyzing either conducted or radiated RF energy between 150 kHz and 32 MHz. Operating power is obtained from an internal battery, rechargable from any 105 to 125, or 210 to 250 volt, 50 to 400 Hz source. With the available accessory items, the instrument can be used for the following applications:

1) Conducting radio frequency interference (RFI) surveys to locate the source and/or to analyze the nature of conducted and radiated interference.

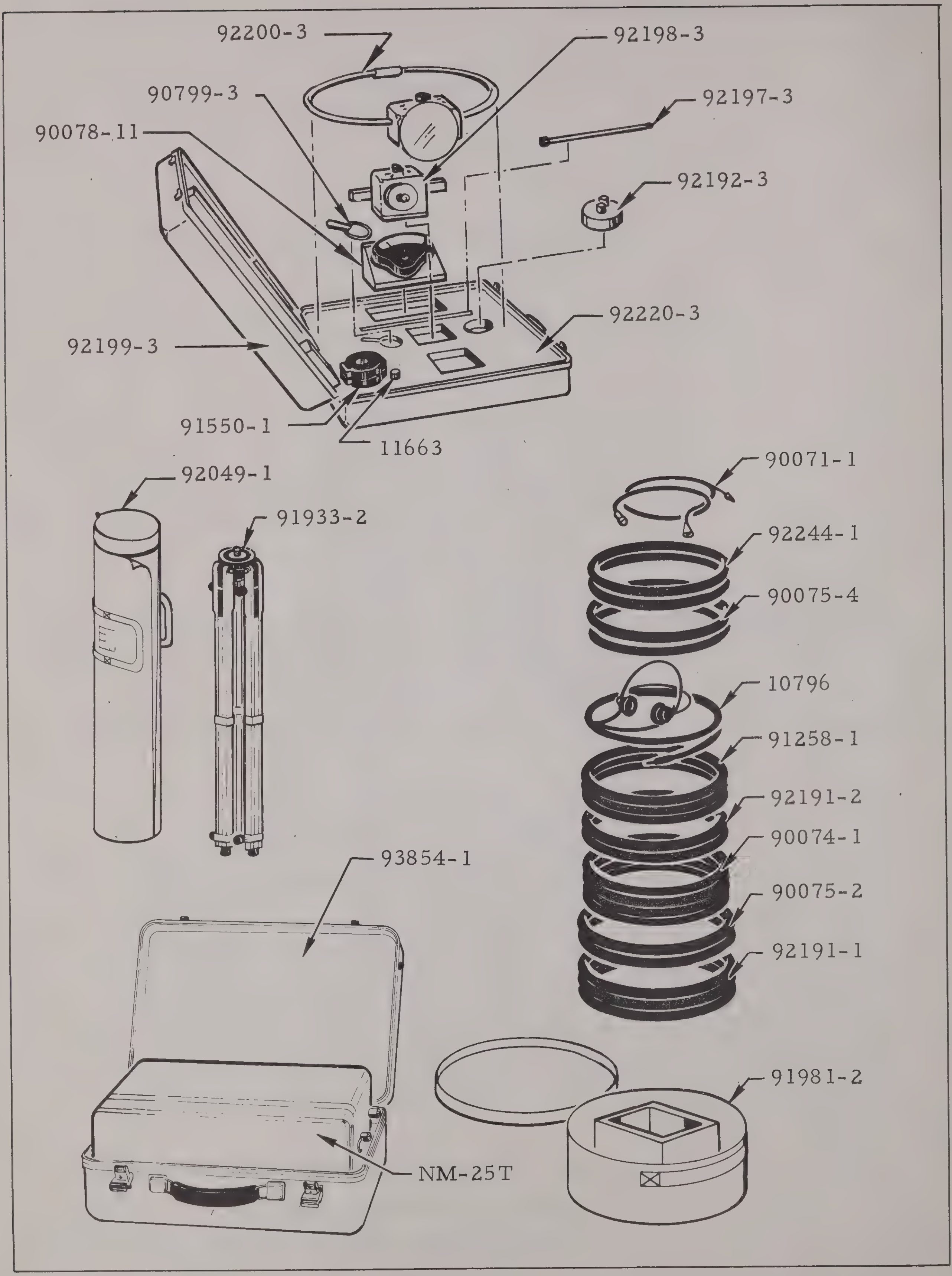

Figure 1-2. STODDART NM-25T RFI Meter and Accessories

2) Performing field intensity measurements to assist in adjusting directional antennas, or to investigate radiation patterns where field strength may vary widely.

3) Making laboratory measurements using the instrument as a sensitive, calibrated, tow-terminal, tunable RF voltmeter.

1.2.1 Equipment Supplied

The equipment supplied is listed in Table 1-1.

Table 1-1. Equipment Supplied

ITEM	STODDART NUMBER	DESCRIPTION
1	NM-25T	Radio Interference-Field Intensity Meter, 150 kHz to 32 MHz.
2	93861-1	Battery Pack.
3	91258-1	AC Power Cable, 6-foot.
4	40350	Instruction Manual.
5	40351	RFI Calculator.

1.2.2 Accessory Items Available

The available accessory items are listed in Table 1-2.

Table 1-2. Accessory Items

ITEM	STODDART NUMBER	DESCRIPTION
1	92191-1	RF Transmission Line, 20-foot
2	92191-2	RF Transmission Line, 2-foot.
3	92197-3	Rod Antenna, Remote, 41 inches
4	92198-3	Antenna Coupler.
5	92192-3	Antenna Coupler Adapter, high impedance
6	92199-3	Ground Plane (used with 92197-3 and 92198-3).
7	92200-3	Loop Antenna, Remote.
8	93410-1	Mounting Adapter, Loop Antenna
9	91550-1	RF Current Probe.
10	11663	Coaxial Connector (N to BNC).
11	90799-3	Loop Probe.
12	10796	Headphones.
13	90078-11	Remote Meter
14	90071-1	Oscilloscope Cable.
15	90074-1	Headphones Extension Cable, 20-foot.
16	90075-2	Remote Meter Cable, 20-foot.
17	90075-4	Y Output Cable, 6-foot.
18	92244-1	X Output Cable, 6-foot.
19	91933-2	Tripod.
20	92049-1	Tripod Bag (Holds one tripod).
21	93854-1	Meter Transit Case.
22	92220-3	Accessory Case.
23	91981-2	Cable Bag.
24	93049-1	Rod Antenna, 9-foot, with Coupler.

Table 1-2. Accessory Items (Cont)

ITEM	STODDART NUMBER	DESCRIPTION
25	91263-1	Impulse Generator
26	91987-2	Graphic Milliammeter Recorder (60 Hz).
27	90075-1	Recorder Cable, 6-foot.

1.3 FUNCTIONAL DESCRIPTION

The NM-25T RFI Meter is a sensitive, calibrated radio receiver, which functions as an RF voltmeter, tunable from 150 kHz to 32 MHz. An internal impulse generator is used for standardizing the overall gain at the frequency of measurement. The RFI Meter contains solid-state circuitry throughout, and is compact, lightweight, and mechanically rugged. Modular construction and printed circuits are used for all major sub-assemblies.

A self-contained, rechargable battery provides completely portable operation. A built-in battery charger circuit, operating from an AC power source, is provided. If desired, the battery can be charged with the RFI Meter turned OFF. Also, the RFI Meter can be operated from an AC power source with the battery removed. A battery meter monitors the battery voltage, and warns the operator when the battery is discharged. The battery charger automatically prevents overcharging.

The RFI Meter has an input impedance of 50 ohms when used as a two-terminal RF voltmeter. It can be used in this configuration to measure RF voltages from 0.1 uV to 1.0 volt. The RFI Meter can be used for field intensity measurements from 1.0 mV/meter to 10 or more volts/meter by connecting the rod antenna and

antenna coupler. Field intensity measurements can also be made by connecting the loop antenna, and orienting the loop for maximum pickup.

The RFI Meter is basically an eight-band superheterodyne receiver having special built-in signal measurement capabilities. It employs single conversion for Bands 3, 4, and 5, and double conversion for the remaining bands. The following measurement functions can be selected by the front panel FUNCTION switch:

1) Field Intensity: Used for measuring average signal values. For example, the FI function is used to measure the average carrier level of narrowband signals. It can also be used to observe signal modulation envelopes with an oscilloscope connected to the SCOPE output receptacle.

2) Quasi-Peak: Used for measuring weighted signal values. The term "weighted" is explained in Section IV. The QP function is used for narrowband signals when the carrier level of either a modulated, or unmodulated signal is to be measured.

3) Peak: Used for measuring peak signal values. This function is most often used for measureing broadband interference.

The FUNCTION switch has two additional positions; i.e., BFO and CAL. Placing the switch in the BFO position permits audible reception of CW type signals. Placing the switch in the CAL position permits calibration, or standardization, of the receiver gain.

The RFI Meter outputs can be monitored at the front panel receptacles. AUDIO, IF OUTPUT, Y-OUTPUT, X-OUTPUT, and SCOPE receptacles are provided. Graphic recordings may be made with a graphic recorder connected to the Y-OUTPUT receptacle.

1.4 CHARACTERISTICS AND SPECIFICATIONS

1.4.1 Electrical Characteristics

1.4.1.1 Frequency Range - 150 kHz to 32 MHz in eight bands, as follows:

BAND	FREQUENCY COVERAGE
1	150 to 305 kHz
2	290 to 590 kHz
3	560 to 1150 kHz
4	1.1 to 2.25 MHz
5	2.1 to 4.3 MHz
6	4.1 to 8.4 MHz
7	8.0 to 16.5 MHz
8	15.5 to 32.0 MHz

1.4.1.2 Type of Receiver - Superheterodyne; single or double conversion, depending on frequency range selected.

1.4.1.3 Type of Signal Capabilities - CW or amplitude modulated carrier, pulse, impulse or random interference.

1.4.1.4 Input Impedance - 50 ohms (coaxial) with an input VSWR less than 1.2.1.

1.4.1.5 Attenuator Range -

SWITCH POSITION	ATTENUATION(dB) RF	IF	METER READING (dB Above 1 μV) MIN.	MAX.
-20 dB/ x 0.1	0	0	-20	20
0 dB/ x 1.0	0	20	0	+40
+20 dB/ x 10.0	20	20	+20	+60
+40 dB/ x 10^2	40	20	+40	+80
+60 dB/ x 10^3	60	20	+60	+100
+80 dB/ x 10^4	80	20	+80	+120

NOTE

IF attenuation is 20 dB with the FUNCTION switch in the CAL position.

1.4.1.6 Sensitivity - Depends on use, input device, and frequency, as follows:

a) Two-Terminal RF Voltmeter: Nominally 0.1 μV, or -127 dB above 1 mW across 50 ohms for unity signal-to-noise ratio.

b) Field Intensity Meter: Sensitivity will vary with frequency and input device:

1) Rod Antenna and Coupler: 1 μV/meter to 15 μV/meter.

2) 15-inch Loop Antenna: 5 μV/meter to 100 μV/meter.

1.4.1.7 Intermediate Frequency - Bands 1, 2, 6, 7, and 8, employ double conversion with the first IF at 1600 kHz, and the second at 455 kHz. Bands 3, 4, and 5, employ single conversion, with the 455 kHz IF.

1.4.1.8 Selectivity - 5.0 kHz impulse bandwidth.

1.4.1.9 Spurious Response Rejection - Image rejection is better than 50 dB; IF and all other spurious response rejection is better than 60 dB.

1.4.1.10 Local Oscillator Rejection - Less than 400 picowatts.

1.4.1.11 Shielding Effectiveness - Better than 60 dB.

1.4.1.12 Dynamic Range - 18 dB (±2 dB) above full-scale meter deflection.

1.4.1.13 Calibration - Internal impulse generator with a fixed repetition rate of 60 PPS and spectral output covering 10 kHz to MHz.

1.4.1.14 Measurement Functions - Three, as follows:

a) Field Intensity: 600 milliseconds charge and discharge time.

b) Quasi-Peak: One millisecond charge, 600 millisecond discharge time.

c) Slideback Peak: Manually controlled; visual indicator employs a movable "white bar" meter.

1.4.1.15 Measurement Accuracy - Frequency as read on dial is within ±2%; voltage measurements are within ±1.5 dB.

1.4.1.16 Panel Meter - Four-inch scale length; calibrated in two decade logarithmic from 1 to 100 μV, and linear from 1 to plus 40 dB.

1.4.1.17 Outputs - Five, as follows:

a) AUDIO: Headphone receptacle; 600-ohm impedance; output power 25 mW; frequency response flat within ±3 dB from 250 to 2500 Hz.

b) IF OUTPUT: BNC coaxial receptacle; 455 kHz IF available at 50-ohm impedance; output voltage 0.1 volt RMS.

c) SCOPE: Oscilloscope BNC coaxial receptacle; impedance greater than 500 kilohms; output voltage varies with percentage of modulation; frequency response flat within ±6 dB from 100 to 2500 kHz.

d) X-OUTPUT: BNC coaxial receptacle; approximately one volt DC for maximum dial rotation.

e) Y-OUTPUT: Two-pole receptacle for remote meter, or graphic recorder; 1500-ohm output impedance; output current 1 ma maximum.

1.4.1.18 Power Source - Internal rechargable NiCa battery of 12 "C" size cells and 1.9 ampere-hour capacity. The nominal voltage is 14 to 17 volts DC, and provides an operating time of 40 hours without recharging. A BATTERY voltage meter is provided, equipped with a 12 to 17 volt expanded scale. An internal regulator circuit provides 12 volts DC, ±0.1 volt, to the RFI Meter.

1.4.1.19 Battery Charger - The charger will operate from any source of 105 to 125, or 210 to 250 volts, 50 to 400 Hz. Power consumption is 5 watts, and the charger circuit provides a maximum

charging current of 150 ma when the battery is fully discharged. A trickle charge current of 40 to 60 ma is provided provided when the battery is fully charged. Charging time is 30 hours with the RFI Meter not operating, and 44 hours with the meter ON.

1.4.2 Physical Specifications

The Model NM-25T RFI Meter is 8-3/4 inches high, 14-3/4 inches wide, and 7-3/4 inches deept With batteries installed, the unit weighs 22-1/2 lbs.

SECTION II

PREPARATION FOR OPERATION

2.1 GENERAL

This Section describes preparation of the NM-25T for measurement of conducted or radiated RF signals at any desired location. Actual operating instructions are given in Section III.

2.2 SELECTION OF A MEASUREMENT LOCATION

Radio frequency interference (RFI) or field intensity measurements often must be made at a designated location. In such cases, the operator must be aware of the effects that surrounding terrain, and nearby metallic objects may have on the radiation to be measured. However, when the location can be chosen, the operator must know how to choose the best location for a particular type of measurement.

Regardless of where the measurements are made, the RFI Meter will indicate the true field intensity at each location. For best results, measurement locations must be as far as possible from sources of spurious electromagnetic interference. Also, greatest accuracy is obtained when the measurement location is at least two wavelengths away from the source of the radiation to be measured. Otherwise, the measurement may be affected by induction field components superimposed upon the radiation component.

When selecting a measurement location, the operator must realize that the amplitude of the RF voltage induced into the rod or loop antenna will be directly proportional to the field intensity of the radiated electromagnetic field - - - in the space occupied by the antenna. The rod and loop antenna each respond only to the vertical component of the electromagnetic field, and are therefore calibrated in terms of the vertical component. Once the measurement location is decided upon, the field intensity is governed by the following factors:

1) The output power of the radiating source.
2) The directional characteristics of the radiating source.
3) The frequency of the radiation.
4) The distance between the radiating source, and the measurement location.
5) Reflections from the earth, atmosphere, or nearby objects.

2.3 POWER REQUIREMENTS

2.3.1 Power Sources

The RFI Meter operates from an internal rechargable battery, both during portable use, and also when connected to an external AC power source. When an external AC power source is used, the built-in battery charger charges the battery. For convenience, the battery may also be charged without turning the RFI Meter ON, and the unit may be operated from the battery charger with the battery removed.

2.3.2 Battery Charger

The battery charger operates from any single-phase AC power source of 105 to 125, or 210 to 250 volts, 50 to 400 Hz. The power line selector switch on the left side of the RFI Meter front panel must be set to the correct position. Also located on the left side of the front panel are the POWER receptacle, power line fuses, and the POWER switch (CHARGE - OFF - ON). A six-foot power cable connects the POWER receptacle to the AC power line. The battery charger regulator prevents overcharging by maintaining the charging current within rated values.

2.3.3 Battery

The internal battery consists of 12-nickel cadmium cells, Sonotone type S104, size "C". The battery is located in an aluminum case in the power supply compartment. The BATTERY meter on the upper left corner of the front panel monitors the battery voltage whenever the POWER switch is set to the CHARGE or ON positions. The RFI Meter can be operated for approximately 40 hours from a fully charged battery before the battery needs recharging.

2.4 SETTING UP THE EQUIPMENT

2.4.1 Basic Test Configuration

The STODDART NM-25T is an extremely versatile test instrument, and can be connected with its accessory items in many different ways. However, the following are the basic test configurations:

1) The RFI Meter can be mounted on the tripod, and either the rod antenna and antenna coupler,

or the loop antenna, can be mounted on top of the RFI Meter, and connected as shown in Figure 1-1.

2) The RFI Meter can be placed on a bench, or other flat surface, and the rod antenna and antenna coupler installed on the ground plane. The ground plane can be mounted on the tripod and located up to 20 feet from the RFI Meter. If the loop antenna is used, it can be mounted directly on the tripod.

3) The RFI Meter can be connected to 50-ohm, high impedance, or current probe input sources for measurement of conducted signals. It can also be connected to a loop probe input device to detect radiation leakage from shielded enclosures.

2.4.2 Adjusting the Tripod

Adjust the tripod as follows:

a) Loosen the lower knobs on all three legs, and adjust the extension sections for the desired height.

b) Tighten the lower knobs to lock the extension sections in place.

c) Loosen the upper knobs on all three legs, and spread the legs to the position that provides greatest stability.

d) Tighten the upper knobs to lock the legs in place.

2.4.3 Preparing the RFI Meter for Use

Prepare the RFI Meter for use as follows:

a) Mount the RFI Meter on the tripod, or place it on a bench or other flat surface.

CAUTION

The RFI Meter can be operated in any position, but during calibration, the front panel must be vertical, within ±45 degrees.

b) If an external AC power source of 105 to 125, or 210 to 250 volts, 50 to 400 Hz is available, the RFI Meter can be connected to the AC power source as follows:

1) Set the 105V - 125V switch on the front panel to the position corresponding to the available line voltage.

2) Connect one end of the six-foot AC power cable to the POWER receptacle on the front panel of the RFI Meter. Connect the other end to the AC power source.

2.4.4 Connecting the RF Cable

Either the two or 20-foot RF cable may be used. Both are coaxial cables with BNC connectors at each end. The two-foot RF cable is used when either the rod or loop antenna is mounted

on top of the RFI Meter. The 20-foot RF cable is used when either the rod or loop antenna is mounted on the tripod. The 20-foot RF cable is also used whenever the RF current probe, or RF loop probe, are used as the signal pickup devices.

One end of the cable is connected to the RF INPUT receptacle on the front panel of the RFI Meter, and the other end is connected to the signal pickup device. For conducted measurements, the other end can be connected directly to any 50-ohm signal source - - - provided that the total DC plus RF power does not exceed 0.5 watt. This end can be connected to higher or lower impedance signal sources if an impedance mismatch can be tolerated.

2.4.5 Connecting the Loop Antenna

Mount the loop antenna on top of the RFI Meter. Fasten the antenna in place by tightening the screws on the base of the loop assembly.

Mount the RFI Meter (with attached loop antenna) on the tripod so it may be rotated. Loosen the center knob on the tripod and rotate the RFI Meter to the desired antenna orientation position, then tighten the center knob.

When the loop antenna is to be located remotely from the RFI Meter, mount the loop assembly directly on the tripod by adjusting the center knob. The antenna can then be oriented to any desired position around the tripod vertical axis. Use the 20-foot RF cable to connect the loop antenna to the RF INPUT receptacle on the RFI Meter.

2.4.6 Connecting the Rod Antenna, Antenna Coupler, and Ground Plane

The 41-inch telescopic rod antenna must be attached to the antenna coupler, and extended to its maximum length during use. The antenna coupler, in turn, must be connected to the RF INPUT receptacle on the RFI Meter. The antenna coupler matches the relatively high impedance of the rod antenna to the 50-ohm input impedance of the RFI Meter in each of the eight bands. The rod antenna and antenna coupler can be mounted on top of the RFI Meter, or they can be attached to the ground plane and mounted on the tripod, if desired.

Attach the rod antenna to the insulated coaxial fitting on top of the antenna coupler. Mount the rod antenna and antenna coupler on top of the RFI Meter, and connect the antenna coupler to the RF INPUT receptacle on the RFI Meter with the two-foot RF cable.

When the rod antenna and antenna coupler are to be located remotely from the RFI Meter, attach the coupler to the ground plane by tightening the fasteners on the base of the antenna coupler. Connect the antenna coupler to the RF INPUT receptacle on the RFI Meter with the 20-foot RF cable.

Since the ground plane is not large enough to constitute a true signal-ground, it may be enlarged by attaching a network of radial wires or equivalent conductors for field intensity measurements of better accuracy. Up to 24 wires can be attached to the ground plane. The length of each attached radial wire must equal, or exceed, the height of the antenna. The rod antenna factors (See Figure 3-2 for typical example) are valid <u>only</u> when a true signal ground is used.

2.4.7 <u>Preparing for Conducted Measurements</u>

The RFI Meter and accessories can be connected for conducted measurements from 50-ohm, high impedance, or a current probe input source.

2.4.7.1 <u>50-Ohm Input</u> - Connect the equipment as follows:

a) Prepare the RFI Meter as described in paragraph 2.4.3.

b) Connect one end of the 20-foot RF cable to the RF INPUT receptacle on the RFI Meter.

CAUTION

<u>Do not</u> connect the RF INPUT receptacle to signal sources exceeding 5 volts (AC or DC).

c) Connect the other end of the 20-foot RF cable to the 50-ohm signal source to be measured. Use the proper cable adapters.

d) In cases where an impedance mismatch can be tolerated, the other end of the 20-foot RF cable may be connected to higher or lower impedance signal sources.

When directly measuring the output of a transmitter, first connect a tunable notch filter between the transmitter output, and one end of the 20-foot RF cable. Carefully tune the filter to the transmitter's fundamental frequency to obtain maximum rejection. Do this <u>before</u> connecting the other end of the 20-foot RF cable to the RF INPUT receptacle. Observe the CAUTION following step "b" above.

2.4.7.2 High Impedance Input - Connect the equipment as follows:

a) Prepare the RFI Meter as described in paragraph 2.4.3.

b) Using an "N" to "BNC" adapter, connect one end of the 20-foot RF cable to the output receptacle of the current probe. Connect the other end to the RF INPUT receptacle of the RFI Meter.

CAUTION

If the conductor to be tested is not insulated de-energize the conductor before attaching the current probe. Be sure to center the conductor in the current probe "window".

c) Open the probe and place it around the conductor, or cable group, to be tested.

d) Lock the jaws of the current probe by tightening the thumb screw (or other clamping means provided). Do not allow the current probe, or cable connectors, to make electrical contact with the ground plane or nearby conductors. Also, do not place the probe near strong permanent magnets or the field structures of motors or generators.

2.4.8 Connecting the Loop Probe

The loop probe is used in detecting electromagnetic radiation leakage from shielded enclosures. Its main advantage is

that it can be used in areas where limited accessibility prevents the use of other signal pickup devices. Calibration figures are not given for the loop probe because it is intended primarily for relative indications, rather than actual signal measurement. To connect the loop probe, proceed as follows:

a) Prepare the RFI Meter as described in paragraph 2.4.3.

b) Connect one end of the 20-foot RF cable to the loop probe. Connect the other end to the RF INPUT receptacle of the RFI Meter.

2.5 CONNECTING EXTERNAL RECORDERS

2.5.1 Milliammeter Recorder

Signal amplitude can be plotted against time by connecting a milliammeter recorder to the RFI Meter. Any suitable recorder may be used, but it must have an input resistance of 1500 ohms, and 1 ma must produce full-scale meter deflection. Graph paper used with the recorder can be calibrated in dB, or a correction rule, or scale, can be used to convert plots made on plain paper. Proceed as follows to make the necessary electrical connections:

a) Prepare the RFI Meter as described in paragraph 2.4.3.

b) Connect one end of the Y-output cable to the milliammeter recorder. Connect the other end to the Y-OUTPUT receptacle of the RFI Meter.

2.5.2 X-Y Plotter

Signal amplitude can be plotted against frequency by connecting an X-Y plotter to the RFI Meter. Any suitable X-Y plotter can be used, but the X-input resistance must be 100 kilohms or greater, and the Y-input resistance must be 1500 ohms.

NOTE

Most X-Y plotters have high X and Y input resistances. However, an external 1500 ohm loading resistance may be used to obtain the necessary Y-input resistance.

The X output voltage of the RFI Meter is proportional to the indicated dial frequency throughout each band. The maximum X output voltage for any given band is 1.0 volt DC, and the maximum Y output voltage is 1.5 volts DC. The X and Y-pole sensitivities of the plotter must be adjusted to these voltages. The Y-axis scale of the plotter must be calibrated with respect to the RFI Meter.

Proceed as follows to make the necessary electrical connections:

a) Prepare the RFI Meter as described in paragraph 2.4.3.

b) Connect one end of the X-output cable to the X-input receptacle of the recorder. Connect the other end to the X-OUTPUT receptacle of the RFI Meter.

c) Connect one end of the Y-output cable to the Y-input receptacle of the recorder. Connect the other end to the Y-OUTPUT receptacle of the RFI Meter.

2.6 PRELIMINARY ADJUSTMENTS

2.6.1 Electrical Adjustments

Each STODDART NM-25T is carefully aligned and calibrated before leaving the factory. No further internal adjustments are necessary. However, the following checks should be made periodically to verify that the instrument is operating properly:

a) Prepare the RFI Meter as described in paragraph 2.4.3.

b) Set the POWER switch to the OFF position, and check to see that the pointer on the front panel meter is exactly at mechanical zero. If not, correct by adjusting the screw on the front of the meter case.

c) Leave the AC power cable disconnected, and rotate the POWER switch to the ON position. Check to see that the BATTERY meter reads in the white portion of the scale. If not, the battery must be recharged (see Section III).

CAUTION

Do not operate the RFI Meter from a discharged battery, or the battery may be damaged.

d) Rotate the ATTENUATOR to the plus 80 dB position (no RF input connected). Check to see that the panel meter pointer deflects to the left of the mechanical zero with the CAL

control maximum counter-clockwise. If necessary, adjust the meter compensation potentiometer, R242.

e) Rotate the FUNCTION switch to the CAL position, and set the BAND switch to BAND 1.

f) Obtain the calibration figure for BAND 1 from the RFI Calculator. Standardize the gain for BAND 1 by rotating the CAL control clockwise until the panel meter reading equals the calibration figure.

NOTE

The ATTENUATOR position has no effect on calibration.

g) Standardize the gain for the remaining bands by repeating steps "e" and "f" for each band.

h) Connect the rod or loop antenna, and plug a headset into the front panel AUDIO receptacle. Place the FUNCTION switch in the FI position and tune through each band. Adjust the ATTENUATOR for an "on-scale" reading on the panel meter, and the AUDIO control for a comfortable headset level. Listen for signals to verify that the RFI Meter is receiving on each band.

i) Proceed as follows to check the operation of the slideback PEAK indicator:

1 Tune the RFI Meter to any modulated RF signal. Place the FUNCTION switch in the PEAK position and rotate the PEAK control fully clockwise. Check to see that the movable white bar of the visual peak meter moves all the way to the right (clockwise).

2 Rotate the PEAK knob slowly counter-clockwise and check to see that the movable white bar of the visual peak meter starts to move to the left (counter-clockwise).

2.6.2 Orienting the Loop Antenna

One of the most useful properties of the loop antenna is that it can be used to obtain the approximate bearing of a signal source. However, before it can be used for this purpose it must be oriented toward a true magnetic North bearing. This is accomplished as follows:

a) Prepare the RFI Meter as described in paragraph 2.4.3.

b) Mount the loop antenna on the tripod and connect it to the RF INPUT receptacle of the RFI Meter.

c) Loosen the locknut on the tripod platform, and verify that the loop antenna is free to rotate around a vertical axis on the tripod head.

NOTE

Remove metal objects from pockets and remove magnets and tools from the vicinity before reading the magnetic compass in the following step.

d) Orient the plane of the loop in a "North-South" direction using a magnetic compass. The readings on the azimuth scale directly in line with the loop frame are at 90 and 270 degrees, respectively. Mark these points on the rim of the tripod head. These marks can then be used as a "North-South" reference line.

2.7 TRANSPORTING THE EQUIPMENT

The RFI Meter and accessories can be stored in the transit cases when the equipment is not in use. The transit cases are intended for transportation of the equipment from one measurement location to another.

SECTION III

OPERATING INSTRUCTIONS

3.1 INTRODUCTION

This Section contains a description of the RFI Meter controls and receptacles, instructions for using the signal input devices, operating instructions, calibration instructions, and instructions for charging the internal battery. The term "signal" as used in the text refers to any RF voltage applied at the RF INPUT receptacle on the RFI Meter front panel.

3.2 CONTROLS AND RECEPTACLES

All external operating controls of the RFI Meter are located on the front panel (Figure 3-1). For a description of the front panel controls and receptacles, see Table 3-1. All internal adjustments are described in Section V.

Table 3-1. RFI Meter Controls and Receptacles

CONTROL OR RECEPTACLE	POSITION	FUNCTION
ATTENUATOR	- - -	Selects total signal attenuation in six steps, from -20 to plus 80 dB, as follows:
	-20 dB/ x 0.1	Does not attenuate RF or IF signal. Signal input is one tenth of meter reading in microvolts.

Table 3-1. RFI Meter Controls and Receptacles (Cont)

CONTROL OR RECEPTACLE	POSITION	FUNCTION
	0 dB/ x 1	Does not attenuate RF signal, but does attenuate IF signal by 20 dB.
	+20 dB/ x 10	Attenuates both RF and IF signal levels by 20 dB.
	+40 dB/ x 10^2	Attenuates RF signal by 40 dB, and IF by 20 dB.
	+60 dB/ x 10^3	Attenuates RF signal by 60 dB, and IF by 20 dB.
	+80 dB/ x 10^4	Attenuates RF signal by 80 dB, and IF by 20 dB.
FUNCTION	- - -	Selects measurement functions as follows:
	CAL	Disconnects RF input and energizes impulse generator to standardize receiver gain.
	FI	Weights signal to permit measurement of average signal values.
	QP	Weights signal to permit measurement near the peak value of input signals.
	PEAK	Applies reverse bias to detector for slideback peak signal measurements.
	BFO	Places beat frequency oscillator in operation to permit audible reception of CW signals.
BAND	- - -	Selects tuned circuits for Bands 1 thru 8.

Table 3-1. RFI Meter Controls and Receptacles (Cont)

CONTROL OR RECEPTACLE	POSITION	FUNCTION
TUNING	- - -	Controls the main tuning capacitor in RF tuner; tunes the receiver within the selected band.
POWER (switch)	- - -	Three-position switch, as follows:
	CHARGE	Turns on the battery charging circuit, and charges the battery when the power cable is plugged into the power line.
	OFF	Removes power from the equipment.
	ON	Applies power to the equipment, and charges the battery when the power cable is plugged into the power line.
105 to 125V 210 to 250V	- - -	Power line selector switch. A retaining plate holds the switch in the selected position, showing only the selected input voltage.
METER	- - -	Two-position switch; determines the response time of the front panel meter, as follows:
	SLOW	Lengthens meter response time.
	FAST	Provides normal meter response characteristics.
AGC	- - -	Two-position switch providing ON and OFF for AGC circuits.
CAL	- - -	Adjusts the overall gain of the receiver during calibration.
AUDIO (control)	- - -	Adjusts level of audio output.

Table 3-1. RFI Meter Controls and Receptacles (Cont)

CONTROL OR RECEPTACLE	POSITION	FUNCTION
POWER (receptacle	- - -	AC power input receptacle.
RF INPUT	- - -	RF signal input receptacle.
SCOPE	- - -	Oscilloscope connection receptacle for visual monitoring.
Y-OUTPUT	- - -	Receptacle for connection of milliammeter recorder or remote meter.
X-OUTPUT	- - -	Provides a DC voltage indicating tuning dial frequency in each band.
AUDIO (receptacle)	- - -	Headset receptacle for aural monitoring.
IF OUTPUT	- - -	Provides output signal from IF amplifier.
GROUND	- - -	Binding post for connection of an external ground.

3.3 CALIBRATION INSTRUCTIONS

The NM-25T is calibrated (gain standardized) at the desired measurement frequency as follows:

a) Prepare the RFI Meter as described in Section II (paragraph 2.4.3).

b) Set the POWER switch to the ON position.

c) Set the BAND switch to the proper band, and rotate the TUNING control for the desired frequency.

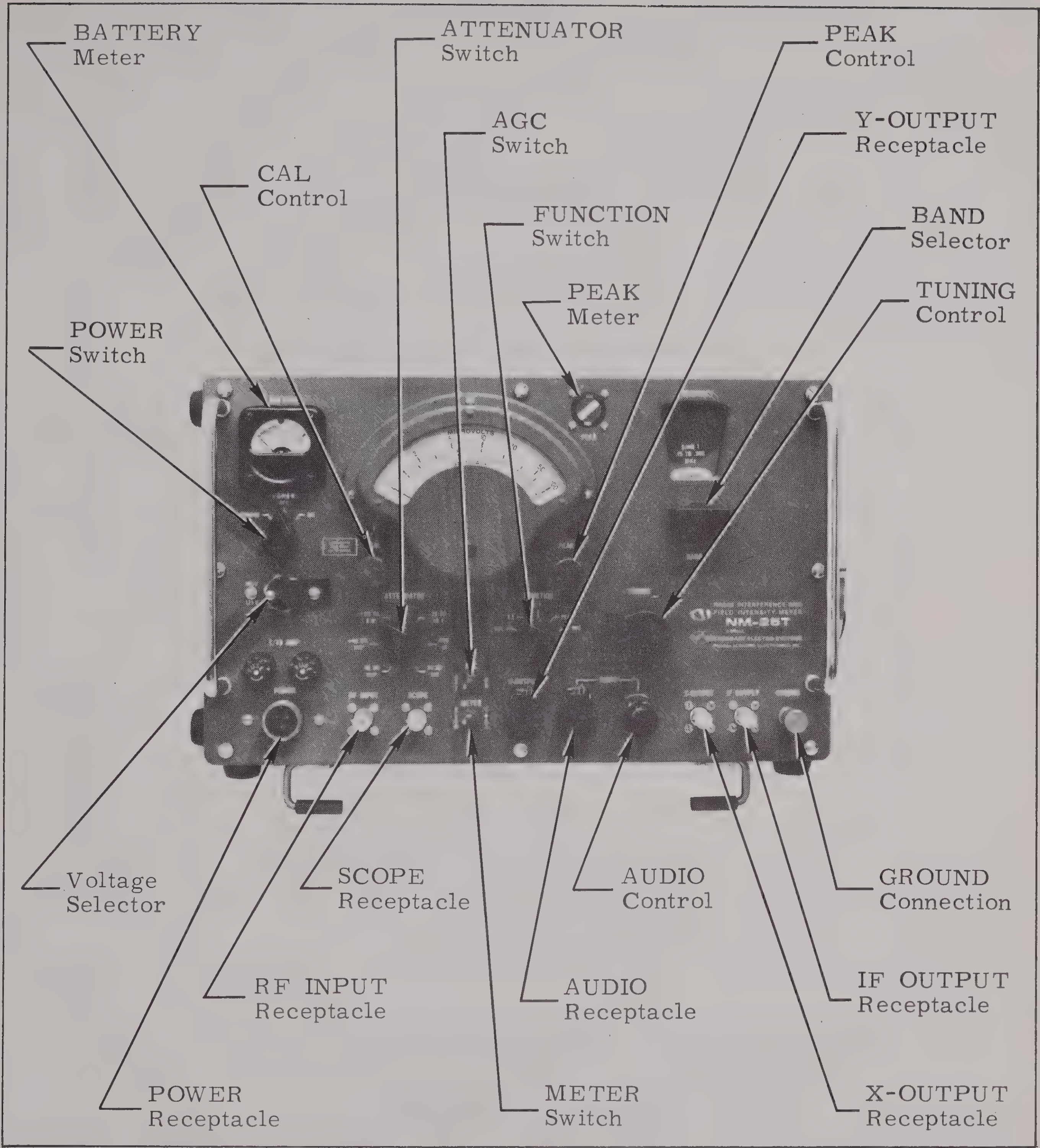

Figure 3-1. STODDART NM-25T RFI Meter, Operating Controls, Indicators and Receptacles

d) Set the FUNCTION switch to the CAL position.

NOTE

The RFI Meter must be calibrated with the front panel within ±45 degrees of vertical.

e) Calibration figures for the RFI Meter are given on the RFI Calculator. Refer to this to find the proper calibration figure for the selected band.

f) Adjust the CAL control so that the front panel meter reads the correct calibration figure on the dB scale.

EXAMPLE: Assume an RF input signal at 250 kHz. Rotate the BAND switch to BAND 1 and tune the RFI Meter to the signal frequency. Rotate the FUNCTION switch to CAL, and refer to the RFI Calculator to find the calibration figure for BAND 1. If the calculator gives a calibration figure of 35.5 dB, adjust the CAL control for a reading of 35.5 dB on the dB scale of the panel meter.

3.4 OPERATING INSTRUCTIONS

3.4.1 Measurement Capabilities

The NM-25T may be used to measure signals in terms of peak, quasi-peak, or average values. The desired measurement depends on the application of the equipment, and the nature of the signal.

The desired measurement function is selected by rotating the FUNCTION switch to the PEAK, QP, or FI position. When the proper signal input device is used, the three functions may be used for measurement of conducted or radiated signals.

3.4.2 Average Value Measurements

Either conducted or radiated RF signals may be measured in terms of the RMS value of the average signal level. The presence of symmetrical amplitude modulation from zero to 100% will not affect the results. Perform the measurements as follows:

a) Using the proper signal input device, connect the signal to be measured to the RF INPUT receptacle of the RFI Meter.

b) Calibrate the RFI Meter at the signal frequency, as described in paragraph 3.3.

c) Rotate the FUNCTION switch to the FI position.

d) Tune the RFI Meter to the signal frequency and adjust the ATTENUATOR for an "on-scale" meter reading. Rotate the TUNING knob back and forth to peak the meter reading.

e) Readjust the ATTENUATOR if necessary, to keep the meter reading in the upper portion of the scale. Record the ATTENUATOR setting and the meter reading in μV or dB.

3.4.3 Weighted Value Measurements

Measure the peak values of signals having a relatively fast repetition frequency as follows:

a) Perform steps "a" and "b" of paragraph 3.4.2.

b) Rotate the FUNCTION switch to the QP position.

c) Perform steps "d" and "e" of paragraph 3.4.2.

3.4.4 Peak Value Measurements

Peak value measurements may be made in either of two methods; i.e., by visual, or aural null indication.

3.4.4.1 Visual Null Indication - Perform the visual null indication method as follows:

a) Perform steps "a" and "b" of paragraphs 3.4.2.

b) Set the FUNCTION switch to PEAK position.

c) Rotate the PEAK control fully clockwise, and set the ATTENUATOR so the movable white bar on the visual peak meter moves in a clockwise direction.

d) Slowly rotate the PEAK control counter-clockwise until the movable white bar on the visual peak meter is vertical. Observe the reading on the panel meter as the threshold point is reached.

e) If the reading on the panel meter goes "off-scale", set the ATTENUATOR to the next higher position and repeat steps "c" and "d".

f) If the reading on the panel meter falls in the lower portion of the scale, set the ATTENUATOR to the next lower position and repeat steps "c" and "d".

g) Record the ATTENUATOR setting and the reading on the front panel meter at the threshold point.

3.4.4.2 Aural Null Indication - Perform the aural null indication method as follows:

a) Perform steps "a" and "b" of paragraph 3.4.2.

b) Set the FUNCTION switch to the PEAK position.

c) Connect a headset to the AUDIO receptacle.

d) Rotate the PEAK control fully clockwise, and adjust the ATTENUATOR so that the signal is audible in the headset.

e) Slowly rotate the PEAK control counter-clockwise until the signal just barely becomes inaudible. Observe the reading on the front panel meter as the threshold point is reached.

f) Perform steps "e" thru "g" of paragraph 3.4.4.1.

3.5 MEASURING SINUSOIDAL RF SIGNALS

3.5.1 General Considerations

Sinusoidal RF signals may be measured in average, weighted, or peak values. For unmodulated RF carriers, the FI, QP,

and PEAK detector functions will provide identical meter readings. When measuring carriers that are amplitude modulated by speech signals, the QP and PEAK functions provide nearly identical meter readings. However, when measuring modulation components consisting of sharp pulses having a low repetition rate, the QP meter readings begin to decrease. Under these conditions, the use of the PEAK function is preferred.

3.5.2 50-Ohm Conducted Measurements

When the RFI Meter is used as a two-terminal RF voltmeter across 50 ohms, signal levels are computed either in terms of microvolts (μV) or dB above 1 μV. Refer to Section II for specific instructions and general precautions.

3.5.2.1 Measurements in Microvolts - For measurements in μV, multiply the meter readings in μV by the ATTENUATOR factor (x 0.1 to x 10^4).

EXAMPLE: With an ATTENUATOR setting of X10^2 and a meter reading of 20 μV, the signal level is $20 \times 10^2 = 2000$ μV.

3.5.2.2 Measurements in dB Above One Microvolt - For measurements in dB above 1 μV, add the meter reading in dB to the ATTENUATOR factor (-20 to plus 80 dB).

EXAMPLE: With an ATTENUATOR setting of 40 dB and a meter reading of 26 dB, the signal level is 40 plus 26 = 66 dB above 1 μV.

3.5.3 High Impedance Conducted Measurements

When the RFI Meter (with the antenna coupler and adapter) is used as a two-terminal, high impedance RF voltmeter, signal levels in dB above 1 μV may be found by adding a dB correction factor to the sum of the meter reading and ATTENUATOR factor (both in dB). The correction factor is obtained from the High Impedance Factor Chart (see Figure 3-2 for sample). Refer to Section II for specific instructions and general precautions.

EXAMPLE: With a 6.8 MHz conducted signal, the high impedance factor is 22 dB. An ATTENUATOR setting of 40 dB and meter reading of 26 dB result in a signal level of 40 plus 26 plus 22 = 38 dB above 1 μV. This can be converted into μV by referring to the Conversion Table (Table 3-2).

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3.5.4 RF Current Probe Conducted Measurements

The RF current probe is a broadband RF transformer that can be used for measuring RF currents in a cable or conductor without physically disturbing the circuit. Signal levels can be computed in terms of microamperes (μA) or dB above 1 μA. Refer to Section II for specific instructions and general precautions.

3.5.4.1 Measurements in Microamperes - For measurements in μA, proceed as follows:

a) Adjust the RFI Meter for standard gain and measure the CW signal (voltage output from current probe) in terms of microvolts at the meter input, as described in paragraphs 3.4.2 thru 3.4.4.

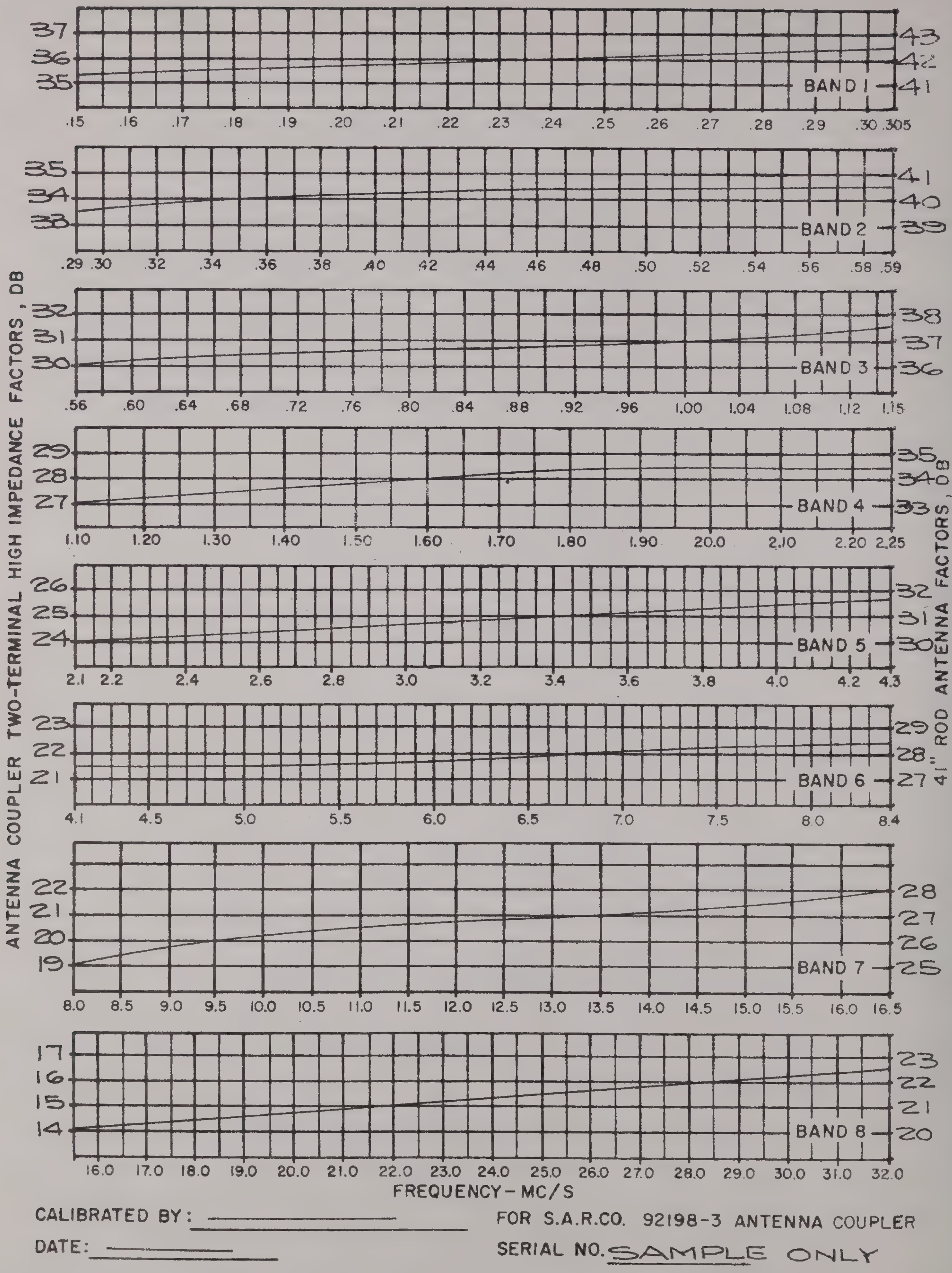


Figure 3-2. Typical Rod Antenna and High Impedance Factors

CONVERSION TABLE 3-2

dB Above 1 μV	μV
-20	0.100
-19	0.112
-18	0.126
-17	0.141
-16	0.159
-15	0.178
-14	0.200
-13	0.224
-12	0.251
-11	0.282
-10	0.316
- 9	0.355
- 8	0.398
- 7	0.447
- 6	0.501
- 5	0.562
- 4	0.631
- 3	0.708
- 2	0.794
- 1	0.891
0	1.00
1	1.12
2	1.26
3	1.41
4	1.59
5	1.78
6	2.00
7	2.24
8	2.51
9	2.82
10	3.16
11	3.55
12	3.98
13	4.47
14	5.01
15	5.62

dB Above 1 μV	μV
16	6.31
17	7.08
18	7.94
19	8.91
20	10.00
21	11.20
22	12.60
23	14.30
24	15.90
25	17.80
26	20.00
27	22.40
28	25.10
29	28.20
30	31.60
31	35.50
32	39.80
33	44.70
34	50.10
35	56.20
36	63.10
37	70.80
38	79.40
39	89.10
40	100.00

dB Above 1 μV	mV
41	0.112
42	0.126
43	0.141
44	0.159
45	0.178
46	0.200
47	0.224
48	0.251

CONVERSION TABLE 3-2 (Continued)

dB Above 1 μV	mV	dB Above 1 μV	mV
49	0.282	85	17.80
50	0.316	86	20.00
51	0.355	87	22.40
52	0.398	88	25.10
53	0.447	89	28.20
54	0.501	90	31.60
55	0.562	91	35.50
56	0.631	92	39.80
57	0.708	93	44.70
58	0.794	94	50.10
59	0.891	95	56.20
60	1.00	96	63.10
61	1.12	97	70.80
62	1.26	98	79.80
63	1.41	99	89.10
64	1.59	100	100.00
65	1.78	**dB Above 1 μV**	**Volts**
66	2.00	101	0.112
67	2.24	102	0.126
68	2.51	103	0.141
69	2.82	104	0.159
70	3.16	105	0.178
71	3.55	106	0.200
72	3.98	107	0.224
73	4.47	108	0.251
74	5.01	109	0.282
75	5.82	110	0.316
76	6.31	111	0.355
77	7.08	112	0.398
78	7.94	113	0.447
79	8.91	114	0.501
80	10.00	115	0.562
81	11.20	116	0.631
82	12.60	117	0.708
83	14.10	118	0.794
84	15.90	119	0.811
		120	1.000

b) Divide the result by the transfer impedance (in ohms) at the test frequency. The quotient is the value of the conducted CW signal in terms of microamperes in the test sample lead.

NOTE

The transfer impedance for the current probe may be determined from the current probe instruction manual. The transfer impedance is obtained by passing a known RF current (I_p) through a primary test conductor, and noting the voltage (E_s) developed across a 50-ohm load. The transfer impedance in ohms (X_t) is then derived from the equation:

$$X_t = E_s/I_p$$

EXAMPLE : At a frequency of 315 KHz the measured signal is 150 μV and the transfer impedance is 0.34 ohms. Then, as outlined in step "b":150/0.34 = 441.1 μA in test sample lead.

3.5.4.2 Measurements in dB Above One Microampere - For measurements in dB above 1 μA, proceed as follows:

a) Adjust the RFI Meter for standard gain and measure the CW signal in dB above 1 μV.

b) Determine the transfer impedance of the current probe in dB at the test frequency (from the graph in the current probe instruction manual). Subtract this from the dB value in step "a". The answer is the value of the conducted CW signal in dB above 1 μA in the test sample lead.

EXAMPLE: Assume a frequency of 200 KHz, a measured signal of 52 dB above 1 μV, and a transfer impedance of -8.0 dB below 1 ohm at 200 kHz. Then, as outlined in step "b": 52 dB -(-8.0 dB) = 60 dB above 1 μA in test sample lead.

3.5.5 Radiated Signal Measurements

When the rod or loop antenna are used, a dB correction factor must be applied. This figure is added to the sum of the meter reading in dB and the ATTENUATOR factor in dB to obtain the signal level in dB above 1 μV per meter. Sample correction factors are given in the Rod Antenna Factor Chart (Figure 3-2), and the Loop Antenna Factor Chart (Figure 3-3).

EXAMPLE: With the rod antenna as the signal pickup device, the antenna factor is 28 dB when measuring a 6.8 MHz signal. If the ATTENUATOR setting is 40 dB, and the meter reading 26 dB, the signal level is 40 plus 26 plus 28 = 94 dB above 1 μV per meter.

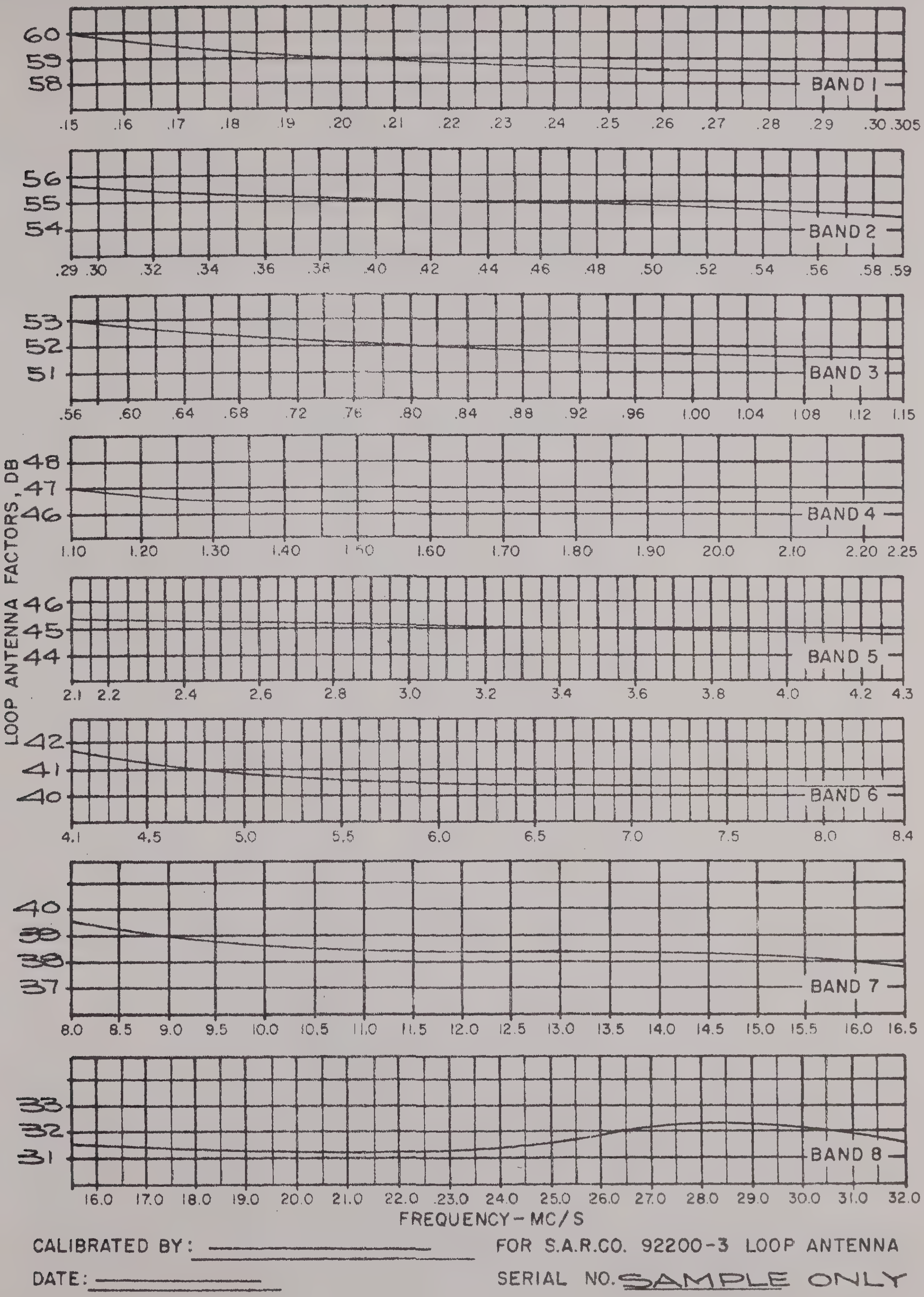


Figure 3-3. Typical Loop Antenna Factors

3.5.6 Conversion of Units

Signal levels in dB above 1 μV can be converted directly into microvolts or millivolts from the Conversion Table, 3-2. The table covers a range of -20 to plus 120 dB above 1 μV, in steps of 1 dB.

EXAMPLE: A radiated signal level of 95 dB above 1 μV per meter can also be expressed as 56.2 mV per meter.

3.5.7 Measuring Sinusoidal RF Signals in the Presence of High Level Interference

When a sine wave RF signal must be measured in the presence of high level random interference, the interference can be compensated for, and the amplitude of the RF signal can be estimated with reasonable accuracy. The procedure for finding the signal level in μV is given on the Correction Chart, Figure 3-4.

EXAMPLE: With a "noise-plus-signal" meter reading of 50 μV, a "noise-only" reading of 30 μV, and an ATTENUATOR setting of x 1, the corrected signal value from Figure 3-4 is 40 μV.

3.6 MEASURING RANDOM INTERFERENCE

Most Military Interference Specifications consider random and impulse interference to be the same, and group both under a term called Broadband Interference. Refer to paragraph 3.7 for the procedure to use when treating broadband interference and disregard the following procedure in this paragraph (and subparagraphs). When dealing with strictly random type interference and accurate data

CORRECTION CHART FOR SINE WAVE SIGNALS IN THE PRESENCE OF HIGH AMBIENT INTERFERENCE OF RANDOM NATURE

1 Adjust for standard gain at the frequency of the incoming "signal." Rotate **FUNCTION** switch to **FIELD INTENSITY**.

2. Note the meter reading of the interfering "noise" in the absence of sine wave signal. If necessary, detune slightly off signal.

3. Tune signal for maximum meter reading and note reading of signal and interfering "noise" combined.

4. Locate the meter reading of "noise plus signal" on horizontal scale of chart.

5. Follow the arc upward until it intersects the horizontal line which represents the "noise only" meter reading.

6. Drop down from the point of intersection to the horizontal scale and read off the corrected meter reading.

7. This is the value of the sine wave signal in the absence of "noise."

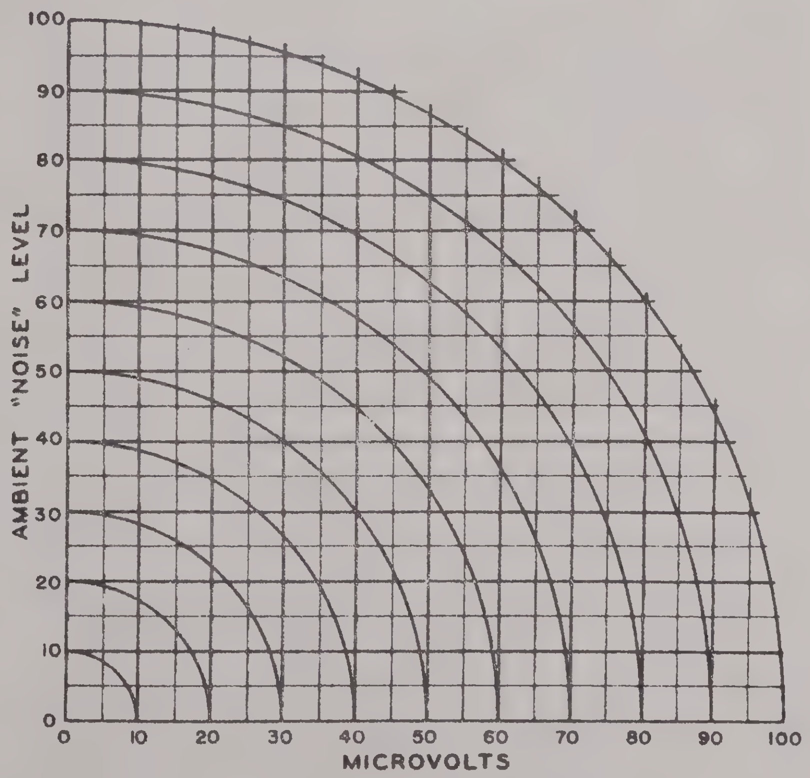


Figure 3-4. Correction Chart for Sine Wave Signals in the Presence of High Level Random Interference

processing (such as correlating data obtained from different bandwidth receivers) is required, independent of Military Specifications, then the following procedures will provide the best results.

NOTE

The RFI Calculator cannot be used for converting the RFI Meter readings of random noise into broadband (BB) terms.

3.6.1 Definition

Random interference is characterized by overlapping noise pulses that are randomly spaced and random in amplitude. Typical sources of random interference are cosmic noise, corona discharges, shot noise from vacuum tubes, and ionized gas discharges. Because of its varying amplitude characteristics, random interference is difficult to measure using the PEAK function. For this reason, the QP and FI functions are preferred.

3.6.2 50-Ohm Conducted Measurements

When the RFI Meter is used as a two-terminal RF voltmeter across 50 ohms, the amplitude of conducted random interference is found by multiplying the meter reading in µV by the ATTENUATOR factor (x 0.1 to x 10^4). To express the product in µV above 1 KHz (or µV above 1 MHz), divide it by the square root of the RFI Meter random noise bandwidth in kHz, or MHz, respectively.

EXAMPLE: With a meter reading of 30 µV, an ATTENUATOR setting of x 10, and a random noise bandwidth of 3.5 kHz, the result is: $30 \times 10/\sqrt{3 \times 5}=$ $300/1.87 = 160.4$ µV per kHz.

3.6.3 High Impedance Conducted Measurements

When the RFI Meter is used as a two-terminal high input impedance RF voltmeter, conducted random interference can be measured in dB above 1 μV by adding the meter reading in dB to the ATTENUATOR factor in dB, and adding this sum to the high input impedance factor in dB. The result is the random noise in dB above 1 μV. This can be converted into μV by referring to Table 3-2. Once the random interference in μV is computed, the result can be divided by the square root of the RFI Meter random noise bandwidth in kHz to obtain an answer in terms of μV per kHz bandwidth.

EXAMPLE: The high input impedance factor for a 6.8 MHz conducted random noise is 22 dB. If the meter reading is 26 dB, and the ATTENUATOR setting is 40 dB, the random noise signal level is 26 plus 40 plus 22 = 88 dB above 1 μV. Referring to Table 3-2, this can be converted into 25.1 mV. For a random noise bandwidth of 3.5 kHz, the random noise can be expressed as:

$E = 25.1 \sqrt{3.5} = 13.4$ mV per kHz.

3.6.4 Radiated Signal Measurements

When the rod or loop antenna are used, add the meter reading in dB to the ATTENUATOR setting in dB, and add the sum to the antenna correction factor in dB. Once random noise in μV per meter is computed, the result can be divided by the square root of the random noise bandwidth in kHz to find μV per meter for 1 kHz.

EXAMPLE: Using the rod antenna, a random noise signal is measured at 6.8 MHz. The antenna factor is 28 dB, the meter reading 26 dB, the ATTENUATOR setting 40 dB, and the random noise bandwidth is 3.5 kHz. The field intensity of the random noise (in dB above 1.0 mV per meter) is 26 plus 40 plus 28 = 94 dB above 1 μV per meter; or 50.1 mV per meter from Table 3-2. This can be expressed in mV-per-meter-per-kHz terms as follows:

E mV/m = $50.1/\sqrt{3.5} = 50.1/1.87 = 26.8$ mV/meter/kHz.

3.7 MEASURING BROADBAND INTERFERENCE

3.7.1 Definition

Often (most Military Specifications on RFI), no distinction is made between random and impulse interference. Both are categorized as "broadband" interference, and treated as impulse interference.

Impulse interference can be defined as one or more electrical disturbances, having a duration in seconds less than the reciprocal of the RFI Meter bandwidth in cycles. If a series of impulses is considered, it is assumed that the interval between the impulses is such that one has died out before the next one starts; i.e., no overlapping. Broadband interference is measured with the peak detector function.

3.7.2 50-Ohm Conducted Measurements

When using the RFI Meter as a two-terminal RF voltmeter across 50 ohms, the peak value of the broadband interference in

μV is computed by multiplying the meter reading in μV by the ATTENUATOR factor (x 0.1 to x 10^4). To express the product in μV above 1 MHz, divide it by the RFI Meter impulse bandwidth in MHz.

> EXAMPLE: With a meter reading of 20 μV, an ATTENUATOR setting of 10^2, and an impulse bandwidth of 5 kHz, the broadband signal voltage is: $E = 20 \times 100/5 = 400$ μV per kHz.

NOTE

> These calculations can be performed easily by use of the RFI Calculator supplied with the NM-25T.

3.7.3 High Impedance Conducted Measurements

When using the RFI Meter as a two-terminal, high input impedance RF voltmeter, broadband interference amplitude can be computed in dB above 1 μV by adding the meter reading in dB to the ATTENUATOR factor in dB, and adding this sum to the high input impedance factor in dB. The result is the broadband interference in dB above 1 μV. This can be converted into mV from Table 3-2, and divided by the impulse bandwidth in MHz to obtain an expression in mV per MHz.

> EXAMPLE: The high input impedance factor is 22 dB for a conducted broadband interference signal at 6.8 MHz. With a meter reading of 26 dB, and an ATTENUATOR setting of 40 dB, the broadband interference is 26 plus 40 plus 22 = 88 dB above 1 μV. Referring to Table 3-2, this value is 25.1 mV. For

an impulse bandwidth of 5.0 kHz, the broadband interference can be expressed as:
25.1/5 = 5.02 mV per kHz.

3.7.4 Current Probe Conducted Measurements

Broadband signal interference can be computed in terms of μA-per-MHz, or in dB above 1 μA-per-MHz.

3.7.4.1 Measurements in Microamperes - For measurements in terms of μA-per-MHz, proceed as follows:

a) Adjust the RFI Meter for standard gain and measure the broadband interference voltage output from the current probe in μV-per-MHz at the RF INPUT receptacle, as described previously.

b) Divide the result of step "a" by the transfer impedance in ohms at the test frequency. The result is the conducted broadband interference in μA-per-MHz in the test sample lead.

EXAMPLE: At 155 kHz, the measured signal is 8000 μV/MHz, and the transfer impedance is 0.39 ohms. Then as outlined in step "b":
I = 8000/0.39 = 20,513 μA/MHz in the test sample lead.

3.7.4.2 Measurements in dB Above One Microampere - For measurements in dB above 1 μA-per-MHz, as follows:

a) Adjust the RFI Meter for standard gain and measure the broadband interference in dB above 1μV-per-MHz.

b) Subtract the transfer impedance of the current probe in dB at the test frequency (see the graph in the current probe instruction manual) from the result obtained in step "a". The result is the conducted broadband interference in dB above 1 μV-per-MHz in the test sample lead.

EXAMPLE: At 175 kHz, the measured signal is 41 dB above 1 μV/MHz, and the transfer impedance is -8.0 dB below 1-ohm. Then, as outlined in step "b": 41 dB -(-8.0 dB) = 49 dB above 1 μA/MHz in the test sample lead.

3.7.5 Radiated Signal Measurements

When the rod or loop antenna are used, add the meter reading in dB to the ATTENUATOR setting in dB, and add this sum to the antenna correction factor. The result is the random interference in dB above 1 μV-per-meter. This can be converted into mV-per-meter with Table 3-2, and divided by the impulse bandwidth in kHz to obtain mV-per-meter-per-kHz.

EXAMPLE: Using the rod antenna at a signal frequency of 6.8 MHz the antenna factor is 28 dB. The meter reading is 26 dB, ATTENUATOR setting 40 dB, and the impulse bandwidth 5 kHz. The broadband interference field intensity in dB above 1.0 μV-per-meter is 26 plus 40 plus 28 = 94 dB above 1 μV-per-meter; or 50.1 mV-per-meter from Table 3-2. This can be expressed in mV-per-meter-per-kHz terms as follows:
E = 50.1/5 = 10.02 mV-per-meter-per-kHz.

3.8 AC POWER SOURCE AND INTERNAL BATTERY USE

3.8.1 Operation From an AC Power Source

To operate the RFI Meter from an AC power source, proceed as follows:

a) Set the 105-125V/210-250V selector switch to the position corresponding to the AC power line voltage. A retaining plate holds this switch in the selected position, displaying the selected voltage.

b) Connect one end of the power cable to the POWER receptacle. Connect the other end to the AC power source.

c) Set the POWER switch to the ON position.

During operation from an AC power line the internal battery is being charged, and the battery voltage is constantly monitored by the BATTERY meter. The expanded scale (12 to 17 volts) of the meter increases the accuracy of the battery voltage reading.

3.8.2 Operation From an AC Power Source With The Internal Battery Removed

The RFI Meter can be operated from an AC power source with the internal battery removed by following the instructions given in paragraph 3.8.1. The power supply inside the RFI Meter produces a regulated 12 volts. The BATTERY meter may read slightly above full scale without an internal battery, but this will not damage the meter.

3.8.3 Operation From The Internal Battery

To operate the RFI Meter from the internal battery, set the POWER switch to ON. Check the battery condition by observing the BATTERY meter. The BATTERY meter reading should be in the white portion of the scale. If the meter reading is in the red portion of the scale, the battery is discharged, and the RFI Meter must be switch OFF to avoid battery damage.

A fully charged battery can operate the equipment for up to 40 hours without recharge.

3.8.4 Charging The Internal Battery

Twelve rechargable 1.25 volt NiCa battery cells, Sonotone Type S104-C, are series connected and housed in an aluminum case. When charging a fully discharged battery, the battery voltage at first rises fast, then starts to stabilize. When the battery is charged to 50-percent of its capacity, the battery voltage remains nearly constant. When discharging a fully charged battery, the voltage at first drops fast, then remains nearly constant until the cells are almost completely discharged. At this time, when the voltage drops sharply, the discharge should be stopped. If the battery is left unused in fully or partially charged condition, a slight discharge occurs, but this is not detrimental to the battery.

WARNING

When operating from an AC power line, do not turn the equipment off by pulling the power plug or throwing the bench power switch. Always place the RFI Meter power switch in the OFF position.

SECTION IV

PRINCIPLES OF OPERATION

4.1 GENERAL

This Section covers the principles of operation of the STODDART NM-25T RFI Meter. The information is presented to assist the user in understanding the circuitry employed in the RFI Meter, and is especially useful in troubleshooting, and other maintenance of the equipment. The text is referenced to the Functional Block Diagram, Figure 4-1, and the Schematic Diagram, Figure 4-2.

4.2 BASIC PRINCIPLES OF OPERATION

The following discussion is based on the Functional Block Diagram, Figure 4-1, and provides a section-by-section description of the equipment. The RFI Meter is basically a superheterodyne receiver, with several additional circuits to provide the necessary measurement functions. This discussion emphasises the various control functions in operation of the equipment.

4.2.1 RFI Meter Requirements

An RFI Meter can be defined as a frequency selective two-terminal RF voltmeter. The NM-25T is designed to measure various types of signals, as are normally encountered in the portion of the spectrum covered by the equipment.

The RFI Meter contains an accurately calibrated step attenuator circuit, permitting the overall measurement range to be extended beyond the capabilities of the panel meter. An impulse generator is contained within the equipment. This circuit provides a spectral output over the tuning range of the equipment that is of known level. This in turn, permits the gain of the RFI Meter to be standardized at the measurement frequency. This is important in obtaining repeatable data between measurements. The final major difference between the RFI Meter and a conventional receiver is in the detector functions employed.

As mentioned previously, various types of signals are encountered. Therefore, the detector functions are designed to provide proper measurements on each of these types of signal. This is referred to as "detector weighting".

4.2.2 RFI Meter Description

The RFI Meter may be divided into six basic sections. These are; the input section RF section, IF section, detector weighting section, audio and peak section, and power supply.

4.2.2.1 Input Section - The input section consists of an RF attenuator, Z101, low-pass filter, Z102, and the impulse generator, Z103.

The input signal at the RF INPUT receptacle is applied to the RF attenuator. The RF attenuator is mechanically linked with the IF attenuator, with the two operating in conjunction with each other to provide the total signal attenuation.

The RF attenuator has six step positions, selected by the ATTENUATOR knob. The overall range of the ATTENUATOR is -20 to plus 80 dB. The RF section of the attenuator is "straight through"

in the first two positions (-20 dB and 0 dB). In each of the succeeding four positions, the RF attenuation at the input is increased by 20 dB (the IF attenuator is "straight through" in the -20 dB position, and 20 dB in all other positions of the ATTENUATOR knob).

From the RF attenuator, the input signal is applied to the cal switch, S106A. This switch is mechanically lined with the FUNCTION switch, S103. In all positions of S103 except CAL, the input signal is applied through the low-pass filter to the RF tuner. However, in the CAL position S106A selects the output of the impulse generator instead, and applies this to the RF tuner to provide the gain standardization function.

The impulse generator consists of a multivibrator circuit, Q135 and Q136, energized in the CAL position. This circuit in turn drives a mercury switch, S107, charging and discharging a delay line, W105. The delay line output is then applied through an attenuator network, R103 thru R111, and the cal switch, S106A, to the low-pass filter.

4.2.2.2 RF Section - The RF section consists of the RF tuner, A101, and the IF converter, Z113.

The RF tuner in turn consists of two RF amplifiers, a mixer, and a local oscillator. The tuner covers the frequency range of 150 kHz to 32 MHz in eight bands. The tuned circuits for each of these bands are on individual tuner boards, mounted in a turret configuration, and selected by the BAND knob. Frequency selection within an individual band is by means of a fourgang variable capacitor, driven by the TUNING knob.

The input signal is amplified by Q101 and Q102, and applied to the mixer, Q103. Output of the local oscillator, Q104, in turn is injected into the mixer, heterodyning to produce the desired IF applied

to the IF converter. This may be either 1600 or 455 kHz, depending on the position of the BAND switch. Bands 1 and 2, and 6 thru 8, employ a 1600 kHz IF, while Bands 3 thru 5 employ a 455 kHz IF.

The IF signal is applied through the converter switch, S101, and appropriate tuned circuits, to Q105. Again, depending on the BAND switch position, Q105 functions either as a 455 kHz IF amplifier, or as a 1600/455 kHz mixer (in conjunction with the second local oscillator, Q106).

The output from Q105 is applied through a 455 kHz filter, T138 and T139, across the CAL control, Z114. The CAL control is used to standardize the RFI Meter gain. From the CAL control, the signal is applied through the IF attenuator, Z115, to the IF amplifier section, Z116.

4.2.2.3 IF Section - The IF section, Z116, consists of the 455 kHz IF amplifiers, second detector, and BFO.

The first two stages, Q107 and Q108, are AGC controlled (with the AGC switch in the ON position). The AGC voltage is applied to voltage variable capacitance diode controlled transformers, T147 and T140 respectively, at the input of these stages. The output from Q108 is applied through a double tuned filter, T141 and T142, to Q109. The filter in turn assists in establishing the desired IF response.

When the FUNCTION switch is set to the BFO position Q113 is energized, producing a 455 kHz signal that is injected into Q109. This permits an audible reception of CW signals.

The 455 kHz signal from Q109 in turn is applied to a push-pull output stage, Q110 and Q111, and appearing across the IF output transformer, T144.

The signal at T144 is applied to the second detector, and also to the IF OUTPUT receptacle. The second detector, CR106 and CR108, functions in conjunction with a bias oscillator, Q112. The bias oscillator operates at a frequency of 850 kHz, and the output is applied to second detector diode CR106, to obtain linear detection at low signal levels.

4.2.2.4 Detector Weighting Section - The weighting circuits, Z117, modify the detector output in accordance with the selected measurement function. Average, weighted, or peak values may be measured, depending on the position of the FUNCTION switch.

In the FI position, the "average" value of the signal is used. In the QP position, a "weighted" value is used. In the PEAK position, a "slideback" measurement function is performed (either aural or visual).

The detected signal level is then applied through a DC amplifier, Q137 thru Q139, to be displayed on the panel meter, M101. This level also is applied to the Y-OUTPUT receptacle, where it is available for use with a remote meter, or an external recorder.

NOTE

The panel meter is calibrated with two scales; i.e., microvolts and dB. The microvolt scale covers zero to 100 microvolts in a logarithmic two-decade scale. The dB scale has approximately linear increments, covering zero to 40 dB.

4.2.2.5 Audio and Peak Section - The demodulated IF signal from CR108 is applied across the AUDIO control, R241, and amplified by Q118 thru Q120. The audio level is then applied to a push-pull output stage, Q121 and Q122, which supplies the 600-ohm headset output at the AUDIO receptacle, and also to the visual PEAK indicator circuit. The visual peak indicator circuit consists of two amplifiers, Q123 and Q124, and the PEAK meter, M102.

In the PEAK position of the FUNCTION switch the AUDIO control is disabled. Instead, a "slideback peak" function is performed. This consists of "biasing off" the circuits with a controllable reverse bias with the PEAK control. As the reverse bias is applied, the visual PEAK meter swings, until a "null" is indicated. The actual peak signal level is then "read" from the panel meter, M101.

4.2.2.6 Power Supply Section - The RFI Meter is normally operated from an internal rechargable 12-volt battery. A battery charging circuit is provided within the RFI Meter, operating from an external AC source (either 105 to 125, or 210 to 250 volts). The battery may be charged with the equipment in operation if desired, and in addition, the RFI Meter may be operated from the charger circuit with the battery removed.

The power supply, A102, consists of a line filter and transformer, and the battery charger. Z200, which in turn consists of a rectifier, charge regulator, and a voltage regulator circuit.

The external AC voltage is applied through a line filter, Z121, to a transformer, T302. The two primary windings of T302 may be connected in parallel (for 105 to 125 volt operation), or series (for 210 to 250 volt operation) by the POWER switch, S302. The secondary output

from T302 is rectified by CR307 thru CR310, and applied to the charge regulator circuit, Q201 and Q202. The charge regulator output is applied to the battery, Z123. The battery output is applied across a voltage regulator circuit, Q203 and Q204, which provides a regulated 12 volt output to the RFI Meter circuitry. The battery voltage is monitored on the BATTERY meter, M103.

4.3 CIRCUIT ANALYSIS

4.3.1 Pickup Devices

The basic pickup devices consist of the rod antenna and coupler, and the loop antenna assembly.

4.3.1.1 Rod Antenna and Coupler - The telescoping rod antenna can be extended to a maximum length of 41 inches, at which point it exhibits an approximate capacity of 10 picofarads. The rod antenna represents a high impedance source compared to the 50-ohm input impedance of the RFI Meter (typically 100 kilohms at 150 kHz, and approximately 500 ohms at 32 MHz). Therefore, the coupler is used to match this high impedance source to the 50-ohm input of the RFI Meter.

The rod antenna coupler consists of a BAND switch, S401, and eight impedance matching networks, T401 thru T408. The frequency ranges of the coupler bands correspond to those of the RFI Meter, with the unused positions shorted to minimize interaction.

The coupler can also be used (without the rod antenna installed) for high impedance conducted measurements. In this application, the antenna coupler adapter is attached to provide connection facilities, and the input capacity remains 10 picofarads.

4.3.1.2 Loop Antenna Assembly - The loop antenna assembly consists of a single-turn 15-inch diameter loop and appropriate matching networks. The loop is electrostatically shielded, and exhibits an inductance of 0.96 microhenry. The impedance of the loop as a source varies from one ohm at 150 kHz, to 200 ohms at 32 MHz.

The loop impedance is matched to the 50-ohm RFI Meter input by the BAND switch, S402, and eight matching networks, T411 thru T418. As in the rod antenna coupler, the frequency ranges correspond to those of the RFI Meter, and the unused positions are shorted.

4.3.2 RF Input Circuits

The RF input circuits (Figure 4-2) comprise the RF attenuator, cal switch, low-pass filter, and impulse generator. Each circuit is separately packaged, and carefully shielded to minimize pickup of noise and other interference.

4.3.2.1 RF Attenuator - The RF attenuator, Z101, consists of four attenuator networks and two straight through conductors in cylindrical housings, that are mounted around a control shaft. The control shaft is mechanically linked to the ATTENUATOR knob, which is calibrated in 20 dB steps from -20 to plus 80 dB.

The input signal is applied at the RF INPUT receptacle, J101, on the front panel of the RFI Meter. Receptacle J101 in turn is connected to the RF attenuator. Rotating the ATTENUATOR knob places the selected network between the input connector, J102, and the output connector, J103. Shorting type switches are used in order to ground the input and output circuits of the remaining attenuator networks.

In the -20 and 0 dB positions of the ATTENUATOR, central conductors directly connect the input and output connectors of Z101.

For the remaining positions, networks are switched into the circuit. The 20 and 40 dB attenuators are "T" pads, and the 60 and 80 db attenuators are double "T" pads. The precision resistors in the attenuators have a maximum power dissipation rating of 0.5 watt, and therefore care must be exercised that the total signal input power does not exceed this rating.

4.3.2.2 Cal Switch - The RF signal from the output connector of Z101 is applied to the input connector of the cal switch assembly, S106. The cal switch is mechanically linked with the FUNCTION switch, S103. When the FUNCTION switch is placed in any position except CAL, the output of the RF attenuator is applied through S106A and S106B to the input of the low-pass filter, Z102. In the CAL position, S106A connects the RF attenuator to ground to prevent spurious signals present at the output of the attenuator from being coupled through the capacity of the switch to the low-pass filter.

4.3.2.3 Low-Pass Filter - The low-pass filter, Z102, has input and output impedances of 50 ohms. The filter consists of two M-derived end sections, and two constant-K center sections. The cut-off frequency is 40 MHz, thus providing a flat response to the upper frequency limit of the RFI Meter. Purpose of the low-pass filter is to reject spurious signals having frequencies beyond the normal range of the equipment. From the output of the low-pass filter, the signal is applied to the input connector of the RF tuner.

4.3.2.4 Impulse Generator - The impulse generator, Z103, constitutes a standard calibrating signal source in the RFI Meter. It consists of a multivibrator, a solenoid-operated mercury switch, and a section of coaxial cable used as a pulse-forming delay line. When the FUNCTION switch is placed in the CAL position, plus 12 volts is applied to the multivibrator, and also through a high resistance to the delay line, W105.

The multivibrator Q135 and Q136, is a free-running symmetrical type, with an output frequency of approximately 60 PPs. A thermistor RT101, is included for temperature compensation. One end of the pulse forming line, W105, is connected to the mercury switch, S107. When the FUNCTION switch is in the CAL position, the other end is connected to plus 12 volts through a voltage divider composed of R106 thru R108.

The output pulses of the multivibrator drive the mercury switch solenoid, L103, causing the field to alternate and open and close the contacts of the switch. This in turn charges and discharges the pulse forming line. The output pulses, developed across a 50-ohm pad, are fed through coaxial cable W104 to S106B, and have a flat spectral output throughout the frequency range of the RFI Meter. The pulses are then routed via S106B to the input of the low-pass filter, Z102.

4.3.3 RF Tuner

The RF Tuner, A101, consists of two tuned RF amplifier stages, a local oscillator, and the first mixer. Incoming signals are amplified in the two tuned stages, and heterodyned in the mixer with the output of the local oscillator. The IF output of the mixer is either 455 kHz or 1600 kHz, depending upon the BAND selected by the user. From the mixer, the signal is applied to the IF converter section, Z113.

4.3.3.1 Turret Assembly - The RF tuner contains a turret-type switching assembly with eight transformer strips, Z104 thru Z111, mounted around a control shaft. The shaft is mechanically linked to the BAND selector knob. As the BAND selector is rotated to the desired position, the proper transformer strip is switched into the RF tuner circuits. Each transformer strip contains the tuned circuits for the two RF amplifiers, the first mixer, and the local oscillator. The resonant

circuits of the selected transformer strip are tuned within the selected band by the ganged variable capacitor, C111. The capacitor has four sections, and has a ceramic shaft to minimize feedback between the two RF amplifier stages. The capacitor is rotated by the front panel TUNING knob.

4.3.3.2 RF Amplifiers - The input signal at P112 is applied through a resistive attenuator pad to the selected input transformer (T101 for BAND 1), which is tuned by C111A. Tracking in this stage is accomplished with a trimmer capacitor (C121 for BAND 1), and the signal is applied to the base of the first RF amplifier, Q101. Forward bias for Q101 is derived from a voltage divider composed of R116 and stabistor CR101. The signal at the collector of Q101 is then applied through either a low-pass filter (Bands 1 and 2) or a tuned circuit (Bands 3 thru 8) to the second RF amplifier, Q102. Bias for Q102 is derived from R118 and stabistor CR102.

The low-pass filter (L105, C123, and C124 for BAND 1) is used to reject spurious high frequency signals, while the interstage tuned circuits maintain relatively constant gain and low VSWR throughout their individual tuning ranges. This is accomplished by application of loading resistances to obtain the proper bandwidth.

The signal at the collector of Q102 is applied across the selected transformer (T102 for BAND 1), which is tuned by C111C. The output from this transformer is then applied to the first mixer, Q103.

4.3.3.3 First Mixer - The input signal and local oscillator signal are heterodyned in the first mixer, Q103, to produce the IF output (either 455 or 1600 kHz, depending on the selected band). The base bias for Q103 is developed across a voltage divider composed of R119 and R120, while the input and local oscillator signals are series injected to the base from

the selected transformer strip. The signal at the collector of Q103 is applied to the output connector, P114, of the RF tuner.

4.3.3.4 Local Oscillator - The local oscillator, Q104, is a Hartley configuration, operating on the high side of the input frequency. The tuned circuit for this stage consists of a transformer (T103 for BAND 1) and capacitor C111D, while the base bias is developed by a voltage divider consisting of R122 and stabistors CR103 and CR104. The stabistors provide thermal stability for Q104.

4.3.4 IF Converter

The IF converter, Z113, consists of a converter switch, 1600 kHz triple tuned filter, 455 kHz tuned circuit, and IF converter/amplifier stage, and a second local oscillator stage. The IF converter functions as a 1600/455 kHz converter in the dual conversion bands (1 and 2, and 6 thru 8), and as a 455 kHz IF preamplifier in the single conversion bands (3 thru 5). The output from the converter is applied through a double tuned 455 kHz filter to the CAL control and IF attenuator, Z115.

4.3.4.1 Converter Switch - The converter switch, S101, is mechanically linked with the BAND switch. In the single conversion bands, the 455 kHz input at J114 is applied through S101A to the 455 kHz IF transformer, T136, and through S101B to the base of Q105. In the double conversion bands, the 1600 kHz input at J114 is applied through S101A to the triple tuned filter, T133 thru T135, and through S101B to the base of Q105. The filter reduces image response in the converter, while coupling capacitors C187 and C189 determine the bandwidth.

4.3.4.2 Double Conversion - In the double conversion bands, the 1600 kHz IF signal is injected in series with a 2055 kHz signal from the second local oscillator, Q106, to the base of the converter/amplifier,

Q105. In this configuration, S101C changes the emitter bias of Q105 by shorting R159, and S101D applies plus 12 volts to energize Q106, connected as a Hartley oscillator. The oscillator tuned circuit consists of T137 and C195, with the base bias derived from a voltage divider, R161 and R162, from the plus 12 volt bus. The 2055 kHz oscillator output is then coupled through C194 to the secondary of T135. The 455 kHz output signal at the collector of Q105 is applied across the double tuned 455 kHz filter, T138 and T139.

4.3.4.3 Single Conversion - In the single conversion bands, the 455 kHz IF signal is applied to the base of Q105, which then functions as a conventional IF preamplifier. The gain of Q105 in this configuration is reduced by the introduction of a fixed degeneration derived from the unbypassed emitter resistance, R159. This affords the same gain through the IF converter in both single and double conversion configurations.

4.3.5 CAL Control and IF Attenuator

4.3.5.1 CAL Control - The 455 kHz IF signal from T139 is applied across the CAL control, Z114, to standardize the gain of the RFI Meter. The CAL control consists of a bridged T attenuator network, with a double ganged potentiometer, R168A and R168B, functioning as the variable attenuator. The input and output resistances, R166 and R167, maintain a 50-ohm impedance through the control. The CAL control is completely shielded to minimize any pickup of noise and/or interference.

4.3.5.2 IF Attenuator - The IF attenuator, Z115, is mechanically linked with the RF attenuator (paragraph 4.3.2.1), and the FUNCTION switch, S103. The IF attenuator is a fixed 20 dB, 50-ohm pi-network, consisting of R169 thru R171.

When the ATTENUATOR knob is set to the -20 dB position, S102 disconnects the pi-network, and the IF signal passes directly to the main IF amplifier, Z116. In all other positions of the ATTENUATOR knob, S102 switches the IF attenuator into the signal path. However, when the FUNCTION switch is in the CAL position, the IF attenuator is in the signal path regardless of the ATTENUATOR knob setting. For any given ATTENUATOR setting, the total signal attenuation is the sum of both the RF and IF attenuation.

4.3.6 IF Amplifier

The IF amplifier, Z116, consists of three single-ended IF stages, a push-pull IF output stage, a bias oscillator, and the second detector. AGC is applied to the first two stages when the AGC switch, S109, is in the ON position, and the IF amplifier operates in a logarithmic mode. When S109 is in the OFF position the IF amplifier operates in a linear mode. The AGC level does not change the gain of the controlled stages, and all stages operate at fixed gain. The AGC level does attenuate the IF signal to provide the control function.

4.3.6.1 AGC Loop - The AGC loop functions with two levels; i.e., the AGC control voltage, and the AGC reference voltage. The AGC control voltage is obtained from the wiper of the "log range" potentiometer, R226, and is a portion of the "weighted" signal displayed on the panel meter, M101. The AGC reference voltage is obtained from a voltage divider composed of R227 and zener diode CR115, from the plus 12 volt bus.

The incoming 455 kHz IF signal is then applied across a "bridge" circuit. One side of the bridge is connected to the AGC reference voltage, while the center, or output, is connected to the AGC control voltage. The basic bridge circuit is a transformer, T147, having two bilfilar wound secondaries. A pair of voltage variable capacitance diodes, CR116 and CR117, are connected in series between the two secondaries, with the output taken at the junction of the diodes.

In a balanced condition, the 455 kHz signals in the secondary windings cancel, and the output at the junction is "zero". However, in an unbalanced condition the 455 kHz signals will not completely cancel, and an IF output appears at the junction of the diodes. The degree of unbalance depends on the difference between the AGC control voltage, and the AGC reference voltage.

When the AGC switch, S109, is in the ON position, an amplitude increase in the RF signal produces a corresponding increase in the level of AGC control voltage. This in turn causes the bifilar secondary windings of the transformer to approach a balanced condition, attenuating the IF signal at the junction of the diodes. Conversely, a decrease in amplitude of the RF signal decreases the level of AGC control voltage, and an unbalanced condition appears across the secondary windings, in turn reducing the IF signal attenuation.

4.3.6.2 AGC Controlled Stages - The 455 kHz signal from the IF attenuator, Z115, is applied to the primary winding of T147. The secondary output at the junction of CR116 and CR117 is then applied through C282 to the base of Q107. Base bias for Q107 is derived from a voltage divider, R220 and R268, with diode CR112 affording good temperature stability. The output from the collector of Q107 is then applied across the primary of T140, which functions in the same manner as T147 (paragraph 4.3.6.1) to provide AGC action to the IF signal.

The secondary output of T140, at the junction of CR118 and CR119, is then applied through C281 to the base of Q108, the second IF amplifier. The output of Q108 is applied to a low-impedance tap on T141 to prevent excessive collector loading. The AGC reference voltage is applied to the two "pin 4" terminals of T140 and T147, while the AGC control voltage is applied to Q107 and Q108 through R200 and R174,

respectively. Base bias for Q108 is derived from R173 and R176, and CR113 provides the temperature stability for this stage.

4.3.6.3 Driver Stage - Transformers T141 and T142 function as a double-tuned 455 kHz filter, with the output applied to the base of Q109. Base bias for Q109 is obtained from R176 and R180, with CR110 providing temperature stability. Negative feedback is applied to the emitter of Q109 from the push-pull output stage through C212, R178 being unbypassed for this purpose (Note: C202 must be disconnected during IF alignment to prevent the negative feedback from affecting the adjustments).

The overload capacity of the amplifier is established by the setting of the "dynamic range" potentiometer, R187. The collector of Q109 is connected through a reverse biased diode, CR105, to the wiper of R187. Thus adjusting R187 varies the level of reverse bias applied to CR105, in turn limiting the signal peaks at the collector of Q109. The output from Q109 is then applied across the primary winding of T143.

4.3.6.4 Output Stage - The push-pull IF output stage, Q110 and Q111, operates in a class "B" common emitter configuration. Base bias for this stage is derived from a voltage divider consisting of R184 and R185, and the common emitter resistance, R186, is unbypassed for degeneration.

The 455 kHz signal across the secondary of T143 is amplified by Q110 and Q111, and appears across the primary winding of the IF output transformer, T144. The secondary of T144 is resonated by C218, and the output signal is applied to the second detector, CR106 and CR108, and is also routed through C230 to the front panel IF OUTPUT receptacle, J120.

4.3.6.5 Bias Oscillator - The second detector diodes exhibit non-linear characteristics at low conduction levels. As linear detection is required, a bias voltage is applied to the diodes in series with the IF output signal to maintain the conduction level above the non-linear region.

The bias oscillator, Q112, operates at approximately 850 kHz. The oscillatory circuit consists of T145 and C221, while base bias for Q112 is derived from a voltage divider, R188 and R189, from the plus 12 volt bus. The output signal across the secondary of T145 is approximately 0.3 volts RMS, and is applied in series with the IF output from T144 to the second detector.

4.3.6.5.1 Second Detector - Two separate second detector circuits are used, CR106 and CR108. Diode CR106 applies the demodulated IF envelope to the detector weighting circuits, Z117, and through C229 to the front panel SCOPE receptacle, J119. In the PEAK position of the FUNCTION switch, S103, the output from CR106 is also applied to the audio amplifier, Z121. In all other positions of the FUNCTION switch, the output of diode CR108 is applied to the audio amplifier, with the front panel AUDIO potentiometer, R241, functioning as the diode load resistance.

4.3.7 Beat Frequency Oscillator

The beat frequency oscillator, Z112, permits audible reception of CW signals when the FUNCTION switch, S103, is set to the BFO position. This applies plus 12 volts DC through S103A to Q113, energizing the circuit to produce a near 455 kHz output that is capacity coupled to the IF driver stage, Q109. This in turn heterodynes with the 455 kHz IF signal to produce an audible signal. The oscillatory circuit comprises C222 and T146, while base bias for Q113 is derived from R195 and R196. The BFO signal is decoupled from the plus 12 volt DC bus by a filter, composed of C225 and R198.

4.3.8 Metering and Weighting Circuits

The metering and weighting circuits, Z117, modify the second detector output in accordance with the selected measurement function, and display the weighted output on the panel meter, M101. The term "weighting" refers to the specific RC time constants introduced into the detector output and AGC circuits for the three measurement functions; i.e., field intensity, quasi-peak, and peak. These three measurement functions are calibrated to produce the same meter reading, in terms of RMS values, for an unmodulated input signal. However, when modulated signals are measured, the meter readings will be different in each of the measurement functions.

4.3.8.1 Metering Circuit - The metering circuit consists of a highly stable three-stage DC amplifier, Q137 thru Q139. The input stage, Q137, employs a field effect transistor to provide an extremely high input impedance. This in turn prevents excessive loading of the detector weighting circuits. Direct coupling is used between the stages, and the output stage, Q139, functions as an emitter follower to drive the panel meter, M101. The emitter output from Q139 is also applied through the "log range" potentiometer, R226, as the AGC control voltage to the IF section (paragraph 4.3.6.1).

An avalanche diode, CR115, and resistance, R227, form a voltage divider from the plus 12 volt DC bus. The plus 9 volts DC at the junction of CR115 and R227 is applied to the meter, M101, and also becomes the AGC reference voltage employed in the IF section (paragraph 4.3.6.1).

The METER switch, S105, controls the response time of the meter. In the SLOW position, capacitor C232 is paralleled with the meter to lengthen the overall response time. The Y-OUTPUT receptacle, J121, also parallels the meter. A remote meter, or an external recorder may be connected at this point if desired.

4.3.8.2 Field Intensity - When the FUNCTION switch, S103, is set to the FI position, a relatively short RC time constant is introduced into the detector output to follow any modulation components present on the RF signal envelope. The detector output is then filtered so the resultant meter reading is proportional to the average value of the RF signal envelope.

In the FI position of S103 the output of CR106 (across C227) is applied to diode load resistance R201. The values of C227 and R201 establish the short RC time constant required at the SCOPE output. The detected signal is then passed through a filter network, C231 and R209, which provides the 600 milliseconds charge and discharge FI time constant. This results in an output amplitude proportional to the average carrier level. The output from C231 is then applied through S103H to the DC amplifier, Q137 thru Q139, to be displayed on the panel meter, M101. The FI-1 potentiometer, R211, permits the meter tracking to be adjusted at the "low" end of the scale in the FI position.

4.3.8.3 Quasi-Peak - When the FUNCTION switch, S103, is set to the QP position, the charge time constant is one millisecond, while the discharge time constant is 600 milliseconds. This in turn permits the detector output to provide a near peak meter reading for input pulse signals having a relatively fast repetition rate. For pulse signals having a lower repetition rate the ratio of QP to PEAK reading increases.

In the QP position of S103 the output of CR106 is applied to a detector load circuit composed of C231 and R209. Capacitor C231 charges through CR106 in one millisecond, and discharges through R209 in 600 milliseconds. This in turn provides an output approaching the peak value of the input signal envelope. The difference between the output in this detector function and the actual peak value, depends on the modulation frequency. The output from C231 is then applied through S103H and

R207 and R208 to the DC meter amplifier. The QP1 and QP100 potentiometers, R210 and R207 respectively, permit the meter tracking to be adjusted at the "low" and "high" ends of the scale in the QP position.

The QP function is useful in determining the percentage of modulation of an RF carrier because the percentage of modulation determines the ratio of QP to FI meter reading. In addition, the shorter charge time constant of the QP weighting circuit reduces the response time, thereby enabling the operator to scan across a given band more quickly than in the FI function

4.3.8.4 Peak - The PEAK position of the FUNCTION switch, S103, provides a "slideback" facility to measure peak signal values. In the PEAK position the output of CR106 is applied through S103B to the input of the audio amplifier, Z121, and the AUDIO potentiometer, R241, is removed from the circuit. A reverse bias is then applied to CR106, adjustable in level by the front panel PEAK potentiometer, R203.

At the start of a peak measurement R203 is set full clockwise, applying maximum reverse bias, and thus preventing CR106 from conducting. As R203 is rotated counter-clockwise the reverse bias decreases, until a point is reached where the bias level is just below the input signal level. At this point CR106 conducts, producing an output across the diode load circuit, C227 and R202, and applying the signal to the audio amplifier.

The output of the audio amplifier is applied to the peak meter amplifier circuit, Q123 and Q124, which has the visual PEAK meter, M102, as its load. With no input at the audio amplifier (CR106 not conducting due to reverse bias) the white bar on M102 is all the way to the right (clockwise). At the point where CR106 conducts the white bar moves to the left (counter-clockwise), and an audible signal will be heard in the headset, connected to the front panel AUDIO receptacle, J118.

A DC voltage proportional to the reverse bias on CR106 is also applied through S103H and R205, R206, and R208, to the DC meter amplifier. The PK1 and PK100 potentiometers, R218 and R206 respectively, permit the meter tracking to be adjusted at the "low" and "high" ends of the scale in the PEAK position.

4.3.8.5 BFO - When the FUNCTION switch, S103, is set to the BFO position, the detector weighting is the same as in the FI position.

4.3.8.6 Calibrate - When the FUNCTION switch, S103, is set to the CAL position, the detector weighting is the same as in the QP position.

4.3.9 Audio and Visual Peak Amplifiers

The audio and visual peak amplifiers are located on the Z121 board. The audio portion consists of two preamplifiers, a driver, and a push-pull output stage. The visual peak portion consists of a two-stage amplifier, and the visual PEAK meter.

In all positions of the FUNCTION switch except PEAK, the demodulated IF envelope from diode CR108 is applied across the AUDIO potentiometer, R241, and coupled through C233 and R242 to the base of the first preamplifier, Q118. In the PEAK position of S103, the output from CR108 is not used, and R241 is removed from the circuit. In this case the output from CR106 is applied to Q118, and the PEAK potentiometer, R203, determines the signal amplitude by setting the conduction point of CR106 (paragraph 4.3.8.4).

4.3.9.1 Audio Amplifier Circuit - The two audio preamplifiers, Q118 and Q119, are identical. The base bias for Q118 is derived from a voltage divider consisting of R243 and R244, while R245 in the emitter leg

is unbypassed to provide degeneration. The output from Q118 is coupled through C234 to the base of Q119, where it is further amplified, and applied to the audio driver stage, Q120.

The base bias for Q120 is derived from a voltage divider consisting of R248 and R249, and degeneration is obtained from the unbypassed resistance, R257, in the emitter leg. The collector load impedance for Q120 is a parallel resonant circuit at approximately 3 kHz. This tuned circuit improves the low frequency response of the amplifier, and the output signal is then coupled to the push-pull output stage, Q121 and Q122.

The audio output stage is a class B, push-pull emitter follower employing complementary symmetry, and is loaded with the 600-ohm impedance of the headset. A voltage divider consisting of R251 thru R254 develops the base bias for Q121 and Q122, and the output signal is coupled through C240 to the front panel AUDIO receptacle, J118, and also to the input of the visual PEAK indicator circuit.

4.3.9.2 Visual Peak Indicator Circuit - The visual peak indicator circuit is a two-stage audio amplifier, Q127 and Q128. With no signal, Q128 is cut-off and no current flows through the meter, M102, in the collector circuit. At this time, the movable white bar of M102 moves to the right. When an audio signal greater than 10 millivolts is applied to the input of the circuit, Q128 conducts. The collector current, limited to 100 microamperes by R236, flows through M102, and the white bar moves to the left. The meter movement is accelerated by a parallel connected network, C267 and R237

4.3.10 Power Supply

The power supply operates the RFI Meter from either a single-phase AC power source of 115 or 230 volts, 50 to 400 Hz, or from an internal rechargable battery. When an AC power source is used, the battery is normally on charge. However, the battery can be charged without turning the RFI Meter on. In addition, the RFI Meter can be operated from an AC power line with the battery removed. A fully-charged battery can operate the equipment for up to 40 hours before requiring recharging. The battery voltage is monitored by the BATTERY meter, M103, on the front panel of the equipment.

The power supply consists of a line filter, power switch, battery, and a plug-in printed circuit board, Z200. The printed circuit board contains the bridge rectifier, charge regulator, and the voltage regulator circuits.

4.3.10.1 Input Circuits - The line filter is an "H" type low-pass filter having a cut-off frequency of 40 kHz. The line filter and the two 1/10 ampere line fuses, F301 and F302, are mounted in a shielded case. The filtered line voltage is then applied to the POWER switch, S108. In the CHARGE and ON positions, S108 connects power transformer T302 to the line through the power line selector switch, S302. This switch connects the two primary windings of T302 in parallel for 105 to 125 volts AC, and in series for 210 to 250 volts AC. The power transformer supplies a nominal 23 volts AC to the bridge rectifier, CR307 thru CR310.

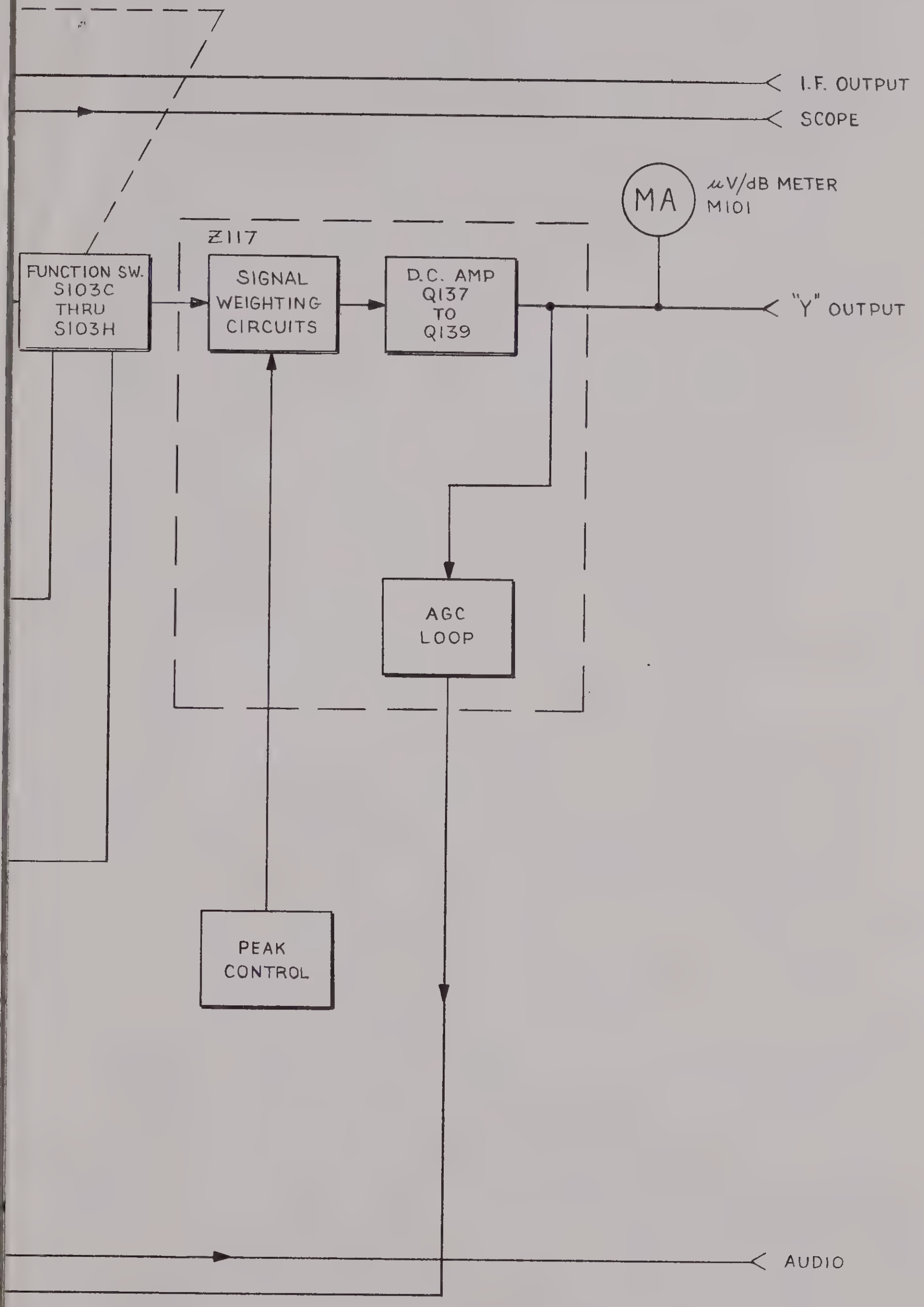
4.3.10.2 Charge Regulator- The rectifier DC voltage is applied to the charge regulator circuit, Q201 and Q202. Transistor Q201 is a series current regulator, and avalanche diode CR311 and resistance R314

maintain the current through Q201 at a constant 170 milliampere. This current is unaffected by either a power line or battery voltage change. The regulated current flows through diode CR317 to the battery, and also to the shunt current regulator, Q202. Diode CR317 prevents the battery from discharging back through the charging circuits. When the battery is fully charged its output is 17 volts, and only a trickle charge current of 40 to 60 milliamperes flows. The rest of the current is routed to Q202. Potentiometer R318 provides a trickle charge current adjustment.

4.3.10.3 Voltage Regulator - The battery voltage rises from 14 to 17 volts during charge, and drops from 17 to 14 volts during discharge. In either case the battery output voltage is regulated at 12 volts, ± 0.1 by a series voltage regulator, Q203 and Q204. The control element is Q203, and avalanche diode CR314 is the reference element, while Q204 functions as the comparator. Stabistors CR315 and CR316 provide temperature stability, and potentiometer R324 provides a fine adjustment for the regulated output voltage. The BATTERY meter, M103, is connected between the battery and the regulated 12 volts, and therefore monitors the battery voltage above 12 volts.

When the POWER switch, S108, is set to the ON position, J108D connects the regulated plus 12 volts DC to the power distribution board, TB101. The battery charge current is then reduced by the current drain of the RFI Meter and the battery charging time is correspondingly longer.

In the CHARGE position of S108, the RFI Meter is disconnected from the regulated 12 volts. However, the 12 volt regulator is still "on", and serves as the reference voltage for the BATTERY meter.



FUNCTIONAL BLOCK DIAGRAM - NM-25T RFI METER

maintain the current through Q201 at a constant 170 milliampere. This current is unaffected by either a power line or battery voltage change. The regulated current flows through diode CR317 to the battery, and also to the shunt current regulator, Q202. Diode CR317 prevents the battery from discharging back through the charging circuits. When the battery is fully charged its output is 17 volts, and only a trickle charge current of 40 to 60 milliamperes flows. The rest of the current is routed to Q202. Potentiometer R318 provides a trickle charge current adjustment.

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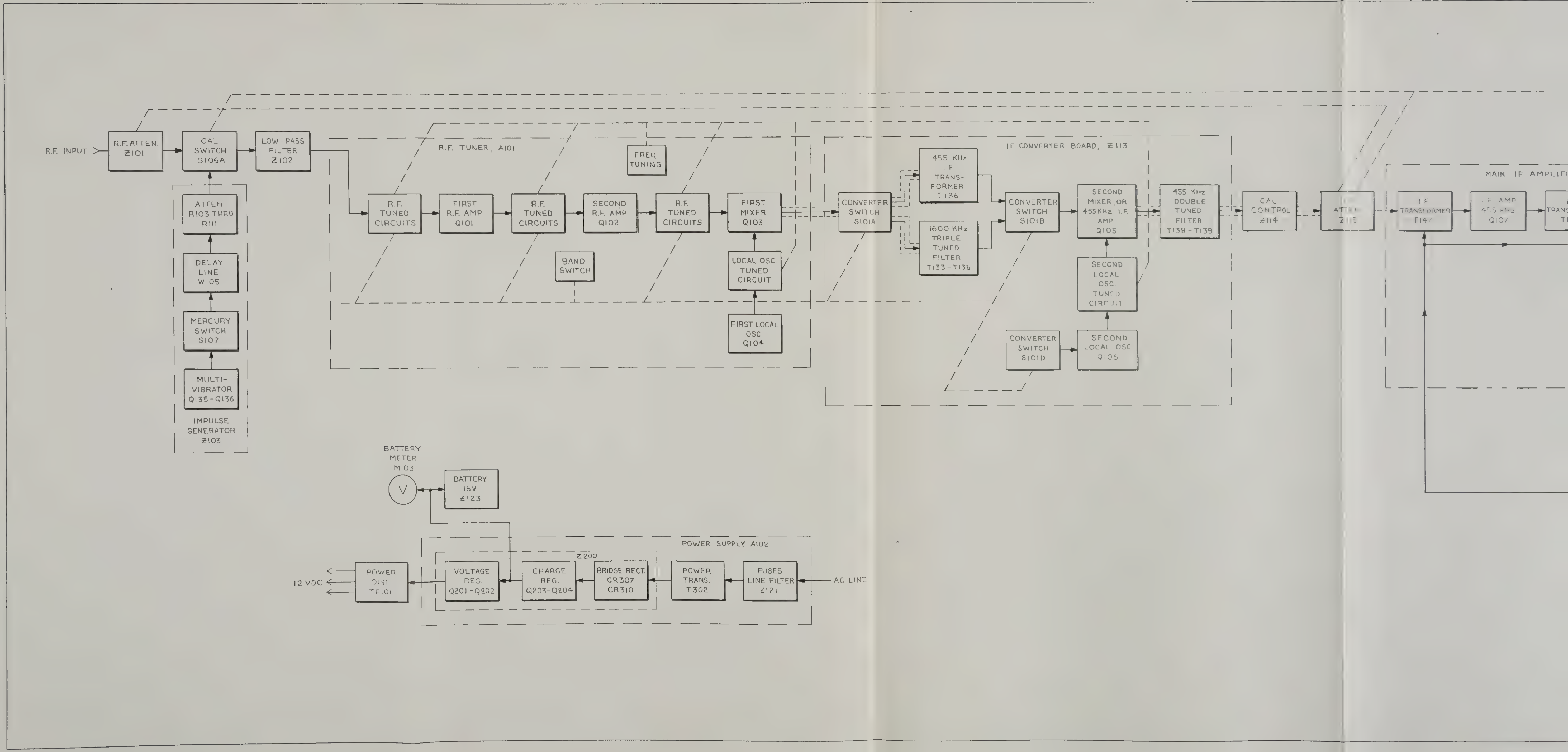
When the POWER switch, S108, is set to the ON position, J108D connects the regulated plus 12 volts DC to the power distribution board, TB101. The battery charge current is then reduced by the current drain of the RFI Meter and the battery charging time is correspondingly longer.

In the CHARGE position of S108, the RFI Meter is disconnected from the regulated 12 volts. However, the 12 volt regulator is still "on", and serves as the reference voltage for the BATTERY meter.



R.F. INPUT
R.F. ATTEN. Z101
CAL SWITCH S106A
LOW-PASS FILTER Z102
ATTEN. R103 THRU R111
DELAY LINE W105
MERCURY SWITCH S107
MULTI-VIBRATOR Q135-Q136
IMPULSE GENERATOR Z103
R.F. TUNER, A101
FREQ TUNING
R.F. TUNED CIRCUITS
FIRST R.F. AMP Q101
R.F. TUNED CIRCUITS
SECOND R.F. AMP Q102
R.F. TUNED CIRCUITS
FIRST MIXER Q103
BAND SWITCH
LOCAL OSC. TUNED CIRCUIT
FIRST LOCAL OSC Q104
IF CONVERTER BOARD, Z113
CONVERTER SWITCH S101A
455 KHz I.F. TRANS-FORMER T136
1600 KHz TRIPLE TUNED FILTER T133-T136
CONVERTER SWITCH S101B
SECOND MIXER, OR 455KHz I.F. AMP. Q105
SECOND LOCAL OSC. TUNED CIRCUIT
CONVERTER SWITCH S101D
SECOND LOCAL OSC Q106
455 KHz DOUBLE TUNED FILTER T138-T139
CAL CONTROL Z114
I.F. ATTEN. Z115
MAIN IF AMPLIFI
I.F. TRANSFORMER T147
I.F. AMP 455 KHz Q107
TRANS
BATTERY METER M103
V
BATTERY 15V Z123
POWER SUPPLY A102
Z200
12 VDC
POWER DIST TB101
VOLTAGE REG. Q201-Q202
CHARGE REG. Q203-Q204
BRIDGE RECT. CR307 CR310
POWER TRANS. T302
FUSES LINE FILTER Z121
AC LINE

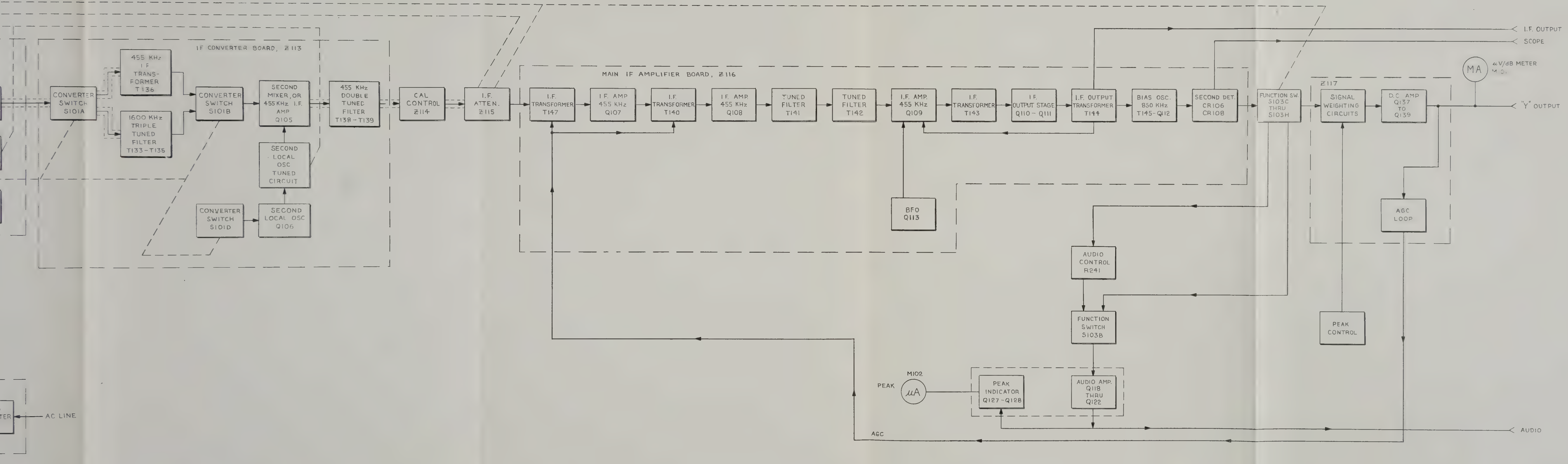


FIGURE 4-1. FUNCTIONAL BLOCK DIAGRAM - NM-25T RFI METER

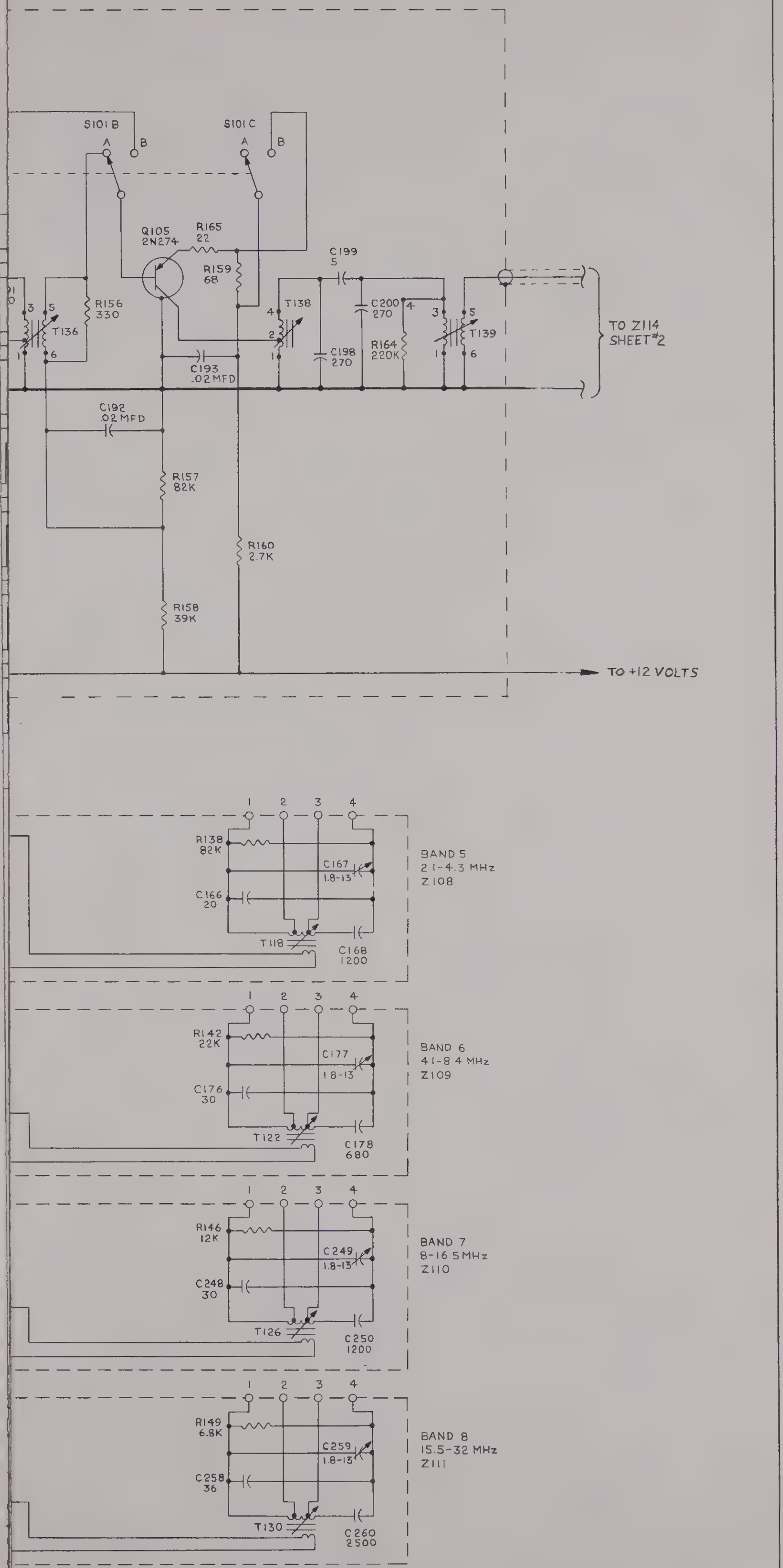
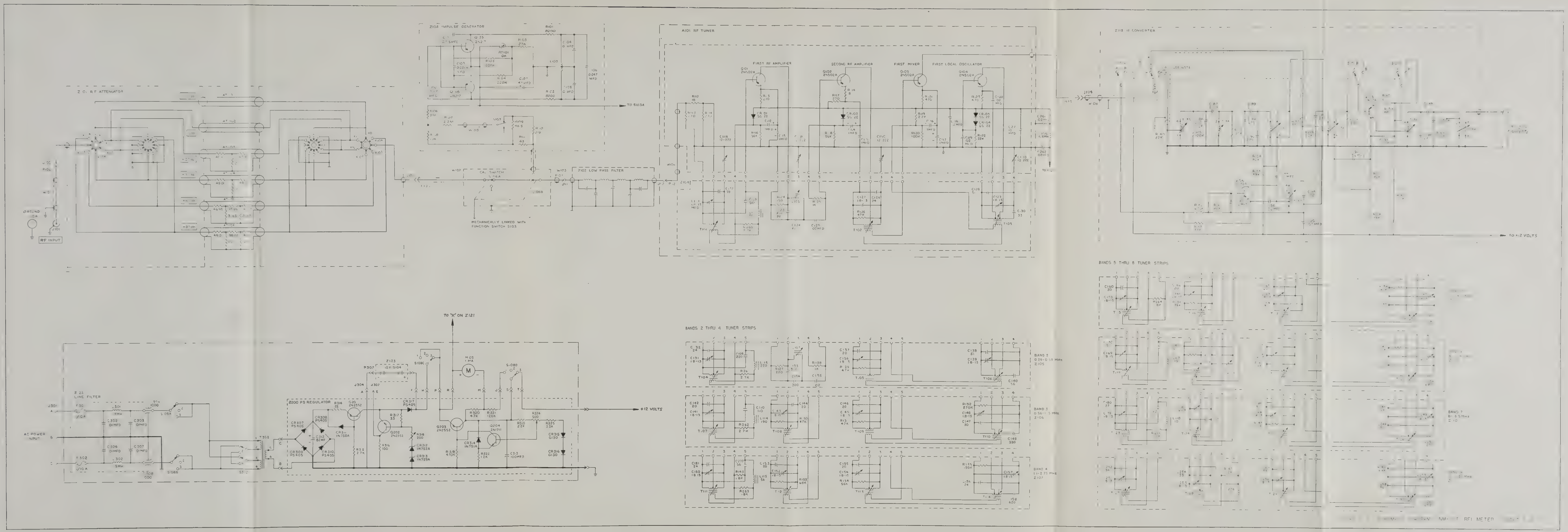


FIGURE 4-2. SCHEMATIC DIAGRAM - NM-25T RFI METER (SHEET 1 OF 2)



Z103 IMPULSE GENERATOR
A101 RF TUNER
FIRST RF AMPLIFIER
SECOND RF AMPLIFIER
FIRST MIXER
FIRST LOCAL OSCILLATOR
TO S103A
Z102 LOW PASS FILTER
CAL. SWITCH
MECHANICALLY LINKED WITH FUNCTION SWITCH S103
GROUND
RF INPUT
TO "K" ON Z121
Z200 PS REGULATOR
LINE FILTER
AC POWER INPUT
+12 VOLTS
TO +12 VOLTS
BANDS 2 THRU 4 TUNER STRIPS
BANDS 5 THRU 8 TUNER STRIPS
RFI METER

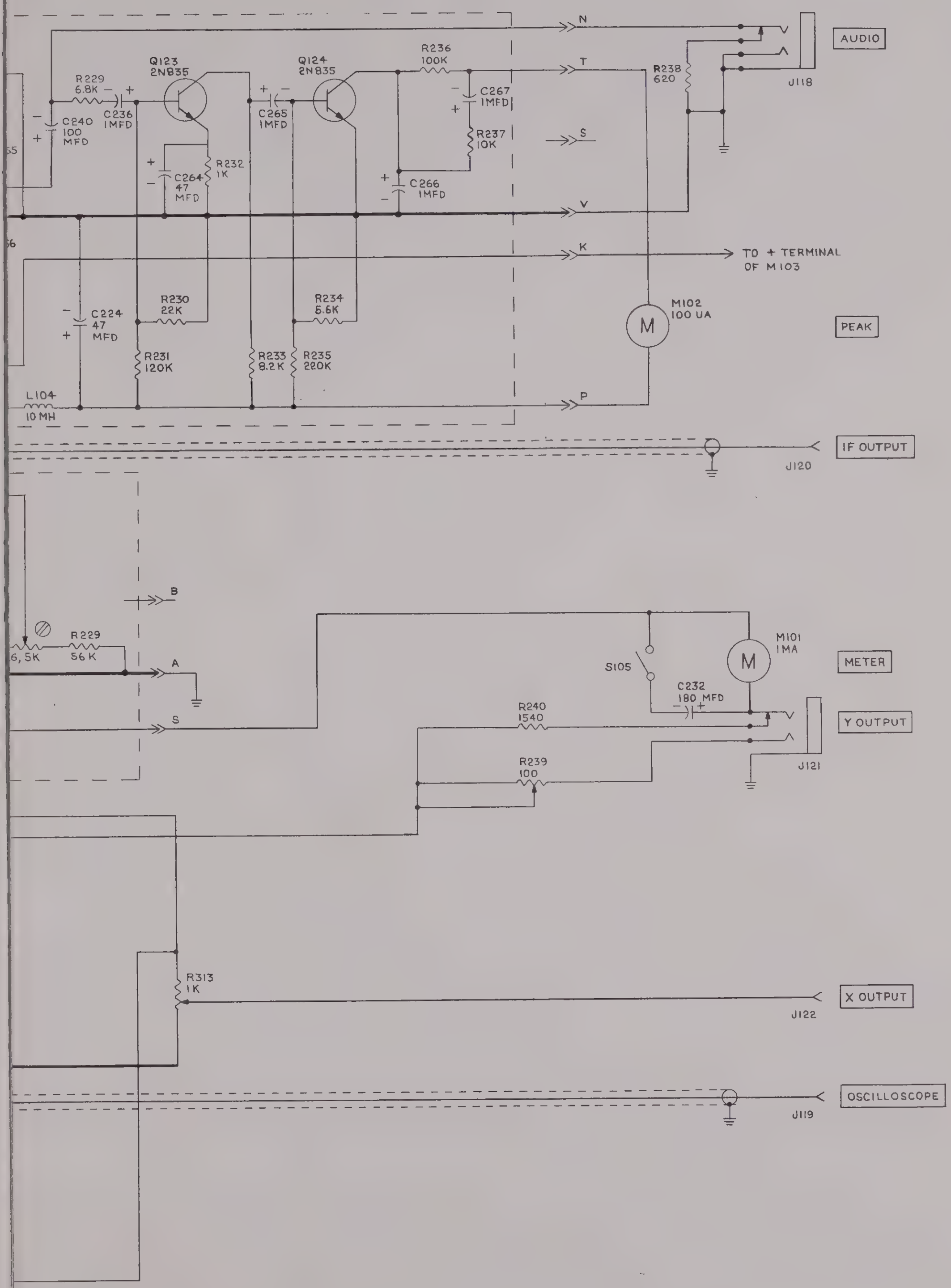
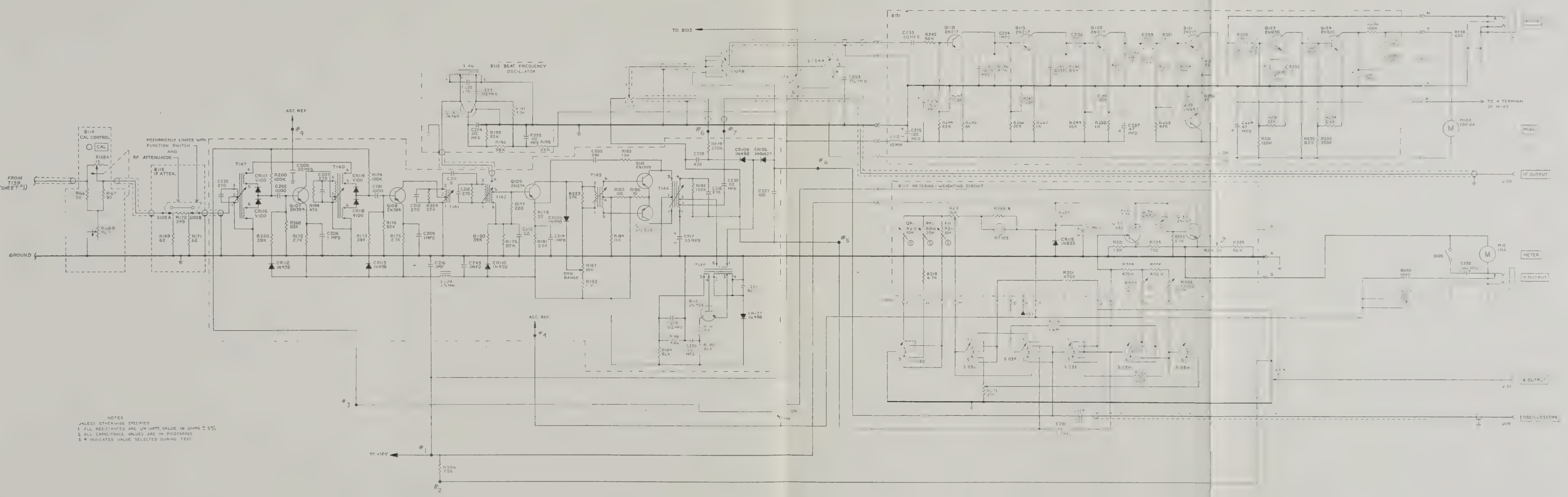


FIGURE 4-2. SCHEMATIC DIAGRAM - NM-25T RFI METER (SHEET 2 OF 2)



NOTES

UNLESS OTHERWISE SPECIFIED

1 ALL RESISTANCES ARE 1/4 WATT, VALUE IN OHMS ± 5%

2 ALL CAPACITANCE VALUES ARE IN PICOFARADS

3 * INDICATES VALUE SELECTED DURING TEST

FIGURE 4-2. SCHEMATIC DIAGRAM - NM-25T RFI METER (SHEET 2 OF 2)

SECTION V

MAINTENANCE

5.1 INTRODUCTION

This Section contains general maintenance information, troubleshooting procedures, alignment and adjustment instructions, and recommended servicing procedures for the solid-state circuitry and printed circuit boards.

5.2 GENERAL MAINTENANCE INFORMATION

5.2.1 Basic Requirements

Each STODDART NM-25T RFI Meter is carefully checked following alignment and calibration at the factory, and no further internal adjustments are required prior to placing the equipment in operation. In the event of a failure or malfunction, troubleshooting or adjustments should be attempted only if proper test equipment is available, and only by technicians experienced in the maintenance and calibration of RFI Meters.

5.2.2 Test Equipment Required for Maintenance

The test equipment required for troubleshooting, alignment, and/or calibration, is tabulated in Table 5-1.

Table 5-1. Test Equipment Required For Maintenance

Description	Recommended Type	Use
DC VTVM	Hewlett-Packard, Model 410B	Transistor DC voltage measurement and power supply adjustment.
RF VTVM	Ballantine, Model 314	RF and IF alignment.
RF Signal Generator	General Radio, Model 1001A	RF and IF alignment and meter scale tracking adjustments.
Frequency Counter	Hewlett-Packard, Model 524/525A	RF and IF alignment.
Tunable RF VTVM	STODDART Model NM-22A, or another NM-25T	RF alignment.

5.2.3 Removal of RFI Meter From Case

The RFI Meter is secured to the case by eight screws in the front panel. To remove the unit from the case loosen these screws and lift out by the carrying handles on the front panel.

WARNING

Do not remove the RFI Meter from the case when the power cable is attached to the AC line, or if the POWER switch is in the CHARGE or ON position.

5.2.4 Power Requirements For Alignment

All alignment and meter scale tracking adjustments are made with the internal power supply regulator output voltage at 12 volts, ±0.1. If deviations are noted in tuning dial calibration or meter scale tracking, or if the gain standardization adjustment is difficult, check the power supply output voltage before attempting to align or adjust the RFI Meter.

5.3 ISOLATING MALFUNCTIONS

5.3.1 Basic Troubleshooting Philosophy

Most malfunctions in an RFI Meter can be located by considering the unit as a conventional communications receiver having a built-in electronic voltmeter. Inspect the equipment carefully and try to isolate the malfunction visually. Check that the operating controls are properly set, as described in Section III. If one of the signal pickup devices is suspected as the source of trouble, check circuit continuity through the device. If the malfunction is established as in the RFI Meter, isolate the trouble to a particular section, then to the defective stage.

5.3.2 Troubleshooting

The Troubleshooting Chart, Table 5-2, will aid in isolating the fault to a particular section of the RFI Meter. Once this has been accomplished, check the transistor element voltages, as tabulated in Table 5-3. A significant difference in one or more of these voltages should be considered cause for component checks in that stage.

Table 5-2

TROUBLESHOOTING CHART

Malfunction	Possible Reason	Procedure
During the charge or operation from the power line, the battery meter fails to read in the blue section	(a) Power line voltage is not connected to the power transformer	1. Check the power line voltage 2. Check Fuses F301, F302 3. Check switches S108 and S302
	(b) Battery charger is defective	4. Check DC voltages on Q201, Q202
	(c) Battery is defective	5. Check the Battery Cells
Operation time of the fully charged battery is short	Battery is defective	1. Check Battery Cells
Battery charge time is too long	Battery charger improperly adjusted	1. Readjust Battery Charger according to Para. 5.7.2
With FUNCTION switch in CAL position, no meter indication, but signal is audible in the headphone	(a) Metering circuit defective (b) Impulse Generator not working	1. Check Voltages of Q137-Q138-Q139 and CR115
Meter indicates, but signal is not audible in headphone	Audio amplifier is defective	1. Check DC Voltages on Q118 to Q122

Table 5-2

TROUBLESHOOTING CHART (Continued)

Malfunction	Possible Reason	Procedure
Visual Peak Indicator is not working	(a) Audio Amplifier defective	1. Check DC Voltages on Q118 to Q122
	(b) Peak indicator circuit defective	2. Check DC Voltages on Q127 to Q128
		3. Check AGC reference for plus 9 VDC
Meter scale tracking cannot be adjusted	Bias oscillator is defective	1. Check DC Voltages on Q112
Receiver is not working in one band	(a) RF strip is defective	1. Check the particular RF strip
	(b) Bandswitch is not contacting	2. Check the Turret Contacts
Receiver is not working in single conversion band or in a double conversion band	(a) IF converter switch is not contacting	1. Check Converter Switch
	(b) Second LO stage is defective	2. Check the DC Voltages on Q106
Receiver is not working in any band	(a) RF amplifier defective	1. Check DC Voltage on Q101-104
	(b) IF converter is defective	2. Check DC Voltage on Q105
	(c) IF main amplifier	3. Check DC Voltage on Q107 to Q111

Table 5-3

TRANSISTOR VOLTAGES

STAGE	FUNCTION	TYPE	V^{V}_{E}	V^{V}_{B}	V^{V}_{C}	NOTES
Q101	1st RF Amplifier	2N502A	11.2	11.0	0	
Q102	2nd RF Amplifier	2N502A	11.2	11.0	0	
Q103	1st Mixer	2N502A	11.3	11.1	0	
Q104	1st Local Oscillator	2N502A	10.7	10.5	0	
Q105	IF Converter, Preamplifier	2N279	8.4	8.2	0	For Single Conversion
Q106	2nd Local Oscillator	2N384	8.4	8.2	0	For Double Conversion Bands
Q107	IF Main Amplifier 1st Stage	2N384	8.9	8.7	0	With No Signal
Q108	IF Main Amplifier 2nd Stage	2N384	8.9	8.7	0	With No Signal
Q109	IF Main Amplifier Driver Stage	2N274	8.9	8.7	0	
Q110	IF Main Amplifier Output Stage	2N599	12.0	11.8	0	With No Signal
Q111	IF Main Amplifier Output Stage	2N599	12.0	11.8	0	With No Signal
Q112	Bias Oscillator	2N599	4.1	3.9	0	

Table 5-3

TRANSISTOR VOLTAGES (Continued)

STAGE	FUNCTION	TYPE	V^V_E	V^V_B	V^V_C	NOTES
Q113	Beat Frequency Oscillator	2N389	7.2	7.0	0	Function Switch in BFO
Q118	Audio Amplifier 1st Stage	2N217	11.0	10.8	0	
Q119	Audio Amplifier 2nd Stage	2N217	11.0	10.8	0.0	
Q120	Audio Amplifier Driver Stage	2N217	10.5	10.3	2.1	Audio Control Down
Q121	Audio Amplifier Output Stage	2N217	6.2	6.0	0.0	Audio Control Down
Q122	Audio Amplifier Output Stage	2N647	6.2	6.4	11.8	Audio Control Down
Q123	Peak Indicator First Stage	2N835	0.7	1.3	6.0	
Q124	Peak Indicator Second Stage	2N835	0.0	0.3	11.5	Indicator Window Black
Q135	Impulse Generator	2N217	11.5	12.5	6.0	Function Switch in CAL position
Q136	Impulse Generator	2N217	11.5	12.5	6.0	Function Switch in CAL position
Q137	Metering Circuit First Stage	C614 FET	5.8	5.5	11.0	With no Signal, FI position

Table 5-3

TRANSISTOR VOLTAGES (Continued)

STAGE	FUNCTION	TYPE	V^V_E	V^V_B	V^V_C	NOTES
Q138	Metering Circuit Second Stage	2N217	11.2	11.0	8.8	With no Signal, FI Position
Q139	Metering Circuit Third Stage	2N647	8.6	8.8	12.0	With no Signal, FI position
Q201	Charge Regulator	2N2552	19.4	19.2	17.9 *	Power Line Voltage 115 V
Q202	Charge Regulator	2N2552	17.4 *	17.2 *	10.0	
Q203	Voltage Regulator	2N2552	16.8 *	16.6 *	12.0	
Q204	Voltage Regulator	2N1711	7.0	7.5	16.6 *	
CR115	Metering Circuit Reference Diode	V_z =	8.6 to 9.0 V			

* Battery fully charged, Power Switch ON.

NOTE: Use the DC VTVM for all transistor voltage measurements.

5.4 ALIGNMENT AND ADJUSTMENT

5.4.1 Alignment of IF Section and Dynamic Range Adjustment

The IF amplifier must be correctly aligned before any other adjustments can be made. Alignment of the IF stages directly affects the meter scale tracking adjustments, and the RF tuner alignment.

5.4.1.1 Alignment of Main IF Amplifier, Z116 - The main IF amplifier alignment procedure is as follows:

a) Remove the RFI Meter from the case, as described in paragraph 5.2.3.

b) Remove the shield plate from the IF amplifier.

c) Set the operating controls as follows:

POWER switch	To ON position
FUNCTION switch	To QP position
ATTENUATOR switch	To 0 dB position
TUNING control	To any position
CAL control	Full clockwise
AUDIO control	Full counter-clockwise
BAND switch	To any position
AGC switch	To ON position

d) Connect the input terminals of a Frequency Counter to the output terminals of a VTVM, and place the VTVM probe within 1/2-inch of the bias oscillator, Q112 (radiation from this oscillator is sufficient for adequate electrostatic pickup by the probe).

e) Note the frequency of the bias oscillator indicated on the Frequency Counter. The frequency should be between 835 and 865 kHz. If not, adjust the slug in T145 as required, using an insulated tuning tool.

f) Locate terminals "A" and "B" on the bottom of printed circuit board Z116. Disconnect capacitor C202 from one of the terminals, opening the negative feedback loop between the IF output and driver stages.

g) Rotate the "dynamic range" potentiometer, R187, fully counter-clockwise (this is the only potentiometer on board Z116).

h) Connect the Frequency Counter to the high level output of an RF Signal Generator. Adjust the signal generator frequency to exactly 455 kHz, and connect the adjustable output level to pins 1 and 3 of T142 (pin 1 is ground).

i) Adjust the Signal Generator output level to produce an "on-scale" reading on the front panel meter.

j) Using the insulated tuning tool, adjust the slug in T144 to obtain maximum indication on the front panel meter. Monitor the signal generator frequency on the counter, maintaining it at 455 kHz (reduce the signal generator output level as necessary to maintain an "on-scale" reading on the meter).

k) Reconnect capacitor C202 (step "f") and connect the signal generator output to the wiper or the CAL potentiometer, R168A.

l) Adjust the Signal Generator output level to produce an "on-scale" reading on the front panel meter.

m) Using the insulated tuning tool, adjust the slugs in T140 thru T142 to obtain maximum indication on the front panel meter. Monitor the signal generator frequency on the counter, maintaining it at 455 kHz (adjust the signal generator output level as necessary to maintain an "on-scale" reading on the meter).

NOTE

A "full-scale" panel meter reading will be obtained with approximately 300 to 400 microvolts input.

5.4.1.2 Dynamic Range Adjustment - After completion of the main IF amplifier alignment, and employing the same test setup, adjust the dynamic range as follows:

a) Connect the Ballantine VTVM to the IF OUTPUT receptacle, J120. Do not use a terminating load.

b) Adjust the Signal Generator output level to produce a "full-scale" reading on the front panel meter. Note the indication on the VTVM.

c) Set the AGC switch to the OFF position and readjust the Signal Generator output level to produce a "full-scale" reading on the front panel meter. Note the indication on the VTVM: This should be the same as in step "b" (AGC ON).

d) Increase the Signal Generator output level ten times, and note the indication on the VTVM.

e) Adjust the "dynamic range" potentiometer, R187, in a clockwise direction until the VTVM indication is exactly nine times the value noted in step "d".

5.4.1.3 Alignment of the IF Converter, Z113 - Align the IF converter as follows:

a) With the Ballantine VTVM connected to the IF OUTPUT receptacle, J120, connect the Frequency Counter to the output of the VTVM.

b) Connect the Signal Generator output to the RF INPUT receptacle of the RFI Meter.

c) Set the RFI Meter BAND switch to the BAND 3 position and tune the signal generator to any frequency within this band.

d) Tune the RFI Meter to the signal generator frequency, carefully adjusting the TUNING control until an indication of exactly 455 kHz is noted on the Frequency Counter.

e) Adjust the slug in T139 for maximum output on the VTVM, continually monitoring the output on the counter to maintain a frequency of 455 kHz (reduce the signal generator output level as necessary to maintain an "onscale" reading on the meter).

f) Adjust the slug in T138 to obtain maximum output on the VTVM. Alternately repeak T139 and T138.

g) Adjust the slug in T136 to obtain maximum output on the VTVM.

h) Set the RFI Meter BAND switch to the BAND 1 position and disconnect the VTVM and counter from the IF OUTPUT receptacle.

i) Position the VTVM probe within 1/2-inch of the second local oscillator, Q106 (radiation from this oscillator is sufficient for adequate electrostatic pickup by the probe).

j) The second local oscillator frequency must be exactly 2055 kHz, indicated on the counter. If necessary, adjust the slug in T137 to obtain this frequency.

k) Reconnect the VTVM and counter to the IF OUTPUT receptacle, and tune the signal generator to any frequency in Band 1.

l) Tune the RFI Meter to the signal generator frequency, carefully adjusting the TUNING control until an indication of exactly 455 kHz is noted on the Frequency Counter.

m) Adjust the slugs in T133 thru T135 for maximum output on the VTVM.

5.4.2 Alignment of the RF Tuner

The RF tuner has been carefully aligned at the factory for optimum performance. Although the alignment procedures are conventional, they must be performed correctly. Do not attempt RF realignment unless absolutely necessary.

5.4.2.1 Necessity for Realignment - Replacing certain critical RF tuner components may necessitate realignment of the tuner. To determine whether or not the tuner requires realignment, proceed as follows:

a) Set the equipment up in a normal operating configuration, as described in paragraph 2.4.3.

b) Set the FUNCTION switch to the CAL position, and adjust the CAL control to obtain a convenient indication on the front panel meter.

c) Carefully tune the RFI Meter from the low to the high end of each band, noting the response on the panel meter.

d) If the response in step "c" differs by more than 10 dB within a particular band, realignment of that band is indicated.

5.4.2.2 Realignment Procedure - The RF tuner realignment procedure for any particular band is as follows:

a) Remove the RFI Meter from the case, as described in paragraph 5.2.3.

b) Remove the cover to the RF tuner assembly.

c) Connect a headset to the front panel AUDIO receptacle.

d) Set the operating controls as follows:

POWER switch	To ON position
FUNCTION switch	To FI position
ATTENUATOR switch	To 0 db position
TUNING control	As called for
CAL control	Full Clockwise
AUDIO control	For comfortable headset level
BAND switch	To desired band
AGC switch	To ON position

e) Connect the 50-ohm output of the Signal Generator to the RF INPUT receptacle of the RFI Meter.

f) Tune the RFI Meter and Signal Generator to exactly the same frequency at the low end of the band to be aligned. Adjust the Signal Generator for a 30-percent modulated output signal.

g) The turret tuner strip corresponding to the selected band, and the transformers and capacitors to be adjusted are tabulated in Table 5-4. Also, refer to Figure 5-1 for the physical location of the various adjustment points on the turret tuner strip.

Table 5-4. RF TUNER ADJUSTMENT POINTS

BAND	TURRET STRIP	1st RF AMPLIFIER TRANS	1st RF AMPLIFIER CAP	2nd RF AMPLIFIER TRANS	2nd RF AMPLIFIER CAP	MIXER TRANS	MIXER CAP	1st LOCAL OSCILLATOR TRANS	1st LOCAL OSCILLATOR CAP
1	Z104	T101	C121	L105 *	- -	T102	C127	T103	C129
2	Z105	T104	C131	L107 *	- -	T105	C136	T106	C139
3	Z106	T107	C141	T108	C143	T109	C145	T110	C148
4	Z107	T111	C150	T112	C152	T113	C154	T114	C157
5	Z108	T115	C159	T116	C161	T117	C163	T118	C167
6	Z109	T119	C169	T120	C171	T121	C174	T122	C177
7	Z110	T123	C179	T124	C181	T125	C184	T126	C249
8	Z111	T127	C251	T128	C253	T129	C256	T130	C259

* Not to be adjusted

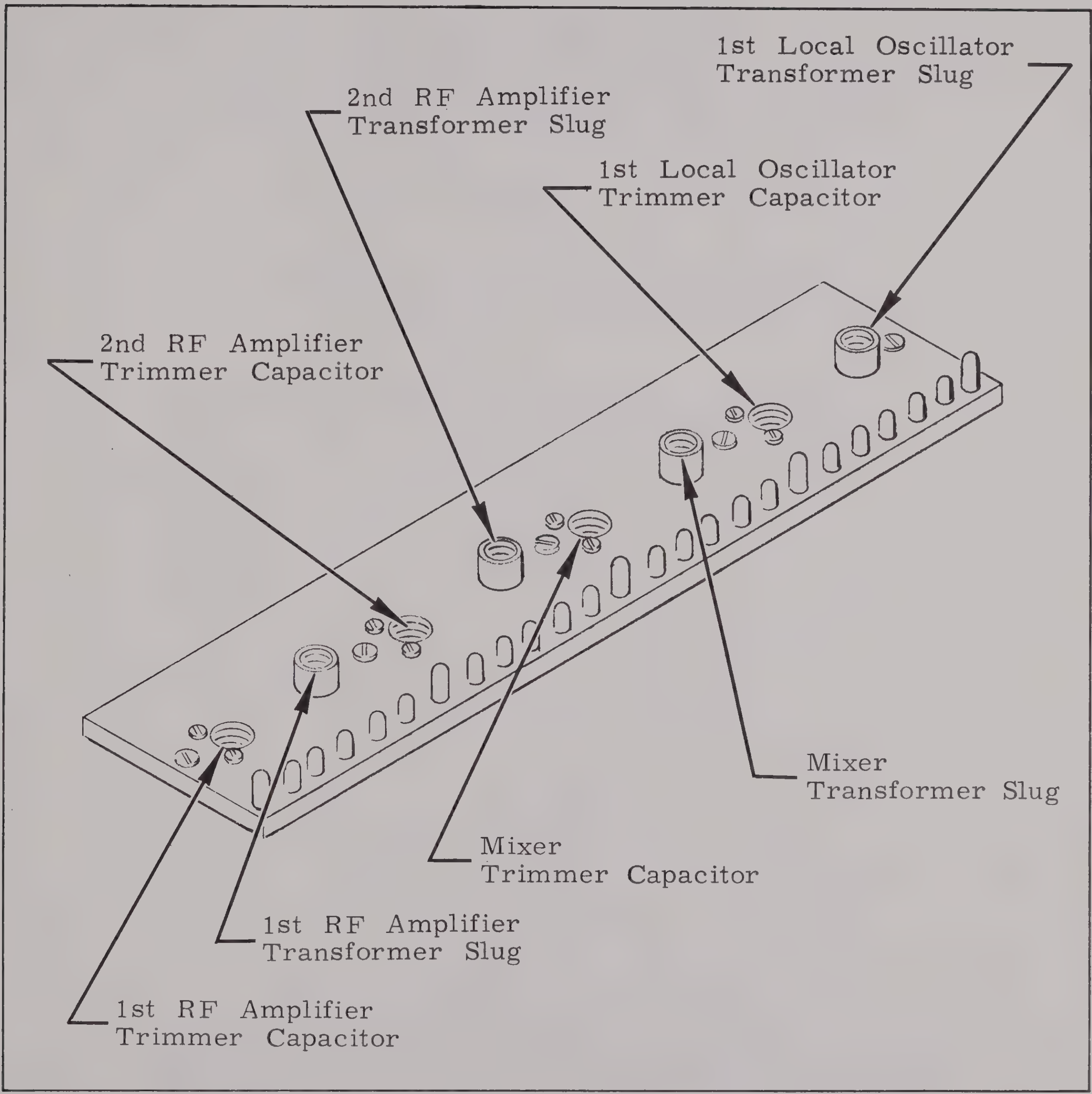


Figure 5-1. Location of RF Tuner Adjustments

h) Using an insulated tuning tool, adjust the slug in the first local oscillator transformer to obtain maximum response on the front panel meter.

NOTE

The Signal Generator tone modulation should now be audible in the headset.

i) Repeat step "f" at the high end of the band being aligned.

j) Using an insulated tuning tool, adjust the first local oscillator trimmer capacitor to obtain maximum response on the front panel meter.

k) Alternately repeat steps "f" thru "j" until no further "peaking" is possible.

NOTE

The final adjustment in step "k" should be at the high end of the band.

l) Set the FUNCTION switch to the CAL position and repeat step "f".

m) Using an insulated tuning tool, adjust the slug in the first RF amplifier transformer to obtain maximum response on the front panel meter.

CAUTION

On Bands 1 and 2, the first interstage coupling consists of a low-pass filter. The slugs in L105 and L107 should not be adjusted during alignment.

n) Repeat step "f" at the high end of the band being aligned.

o) Using an insulated tuning tool, adjust the first RF amplifier trimmer capacitor to obtain maximum response on the front panel meter

p) Alternately repeat steps "1" thru "o" until no further "peaking" is possible, with the final adjustment at the high end of the band.

q) Repeat steps "1" thru "p" for the second RF amplifier and mixer stages until no further "peaking" is possible.

r) Repeat the above procedure for all bands that require realignment.

5.4.3 Meter Scale Tracking Adjustments

The panel meter is "tracked" by aligning the AGC loop transfer characteristics curve at the 1, 10, and 100 points on the logarithmic meter scale.

5.4.3.1 Method of Tracking - The "tracking" adjustments are performed sequentially in the FI, QP, and PEAK positions of the FUNCTION switch. A CW type input signal is used, producing an identical IF output for the three positions of the FUNCTION switch. The meter is then adjusted to provide identical readings for each of the positions. The detector weighting circuits then provide a meter reading proportional to the RMS value of the IF signal.

5.4.3.2 Tracking Procedure - Adjust the meter scale tracking as follows:

a) Remove the RFI Meter from the case, as described in paragraph 5.2.3.

b) Set the operating controls as follows:

POWER switch	To ON position
FUNCTION switch	To FI position
ATTENUATOR switch	To 20 dB position
TUNING control	To any position
CAL control	As called for
BAND switch	To any position
AGC switch	To ON position

c) Connect the 50-ohm output of the Signal Generator to the RF INPUT receptacle of the RFI Meter.

d) Tune the RFI Meter and Signal Generator to exactly the same frequency and adjust the generator output level to 1000 microvolts.

e) Adjust the CAL control to provide a full-scale indication on the panel meter (100 microvolts).

f) Reduce the generator output level to 10 microvolts and observe that the meter indicates 1 microvolt: If the indication is other than 1 microvolt, adjust the FI-1 potentiometer, R211, to obtain proper tracking at this point.

NOTE

In all of the following adjustments clockwise rotation of the potentiometer provides an "up-scale" correction, while a counter-clockwise rotation provides a "down-scale" correction.

g) Increase the generator output level to 100 microvolts and observe that the meter indicates 10 microvolts: If the indication is other than 10 microvolts, adjust the LOG RANGE potentiometer, R226.

NOTE

The meter pointer movement at this time will be opposite the anticipated direction. However, any change in the LOG RANGE setting will necessitate an increase in the CAL control setting to obtain a "full-scale" reading when the generator is set to 1000 microvolts.

h) Repeat steps "d" thru "g" until the panel meter tracks at the 1, 10, and 100 points in the FI position.

CAUTION

Do not readjust the CAL control or LOG RANGE potentiometer during the subsequent steps.

i) Set the FUNCTION switch to the QP position, and adjust the generator output level to 1000 microvolts.

j) Adjust the QP-100 potentiometer, R207, to provide a full-scale indication on the panel meter (100 microvolts).

k) Reduce the generator output level to 10 microvolts and adjust the QP-1 potentiometer, R210, to obtain an indication of 1 microvolt on the panel meter.

l) Repeat steps "i" thru "k" until the panel meter tracks at the 1 and 100 points in the QP position.

m) Set the FUNCTION switch to the PEAK position, and adjust the generator output level to 1000 microvolts.

n) Adjust the PEAK control until the white bar on the PEAK meter is centered (vertical) and observe that the panel meter indicates 100 microvolts: If the indication is other than 100 microvolts, adjust the PK-100 potentiometer, R206, to obtain proper tracking at this point.

NOTE

There will be interaction between the PEAK control and PK-100 potentiometer adjustments. These two controls should be adjusted together until the desired indication is obtained.

o) Reduce the generator output level to 10 microvolts and adjust the PK-1 potentiometer, R218, to obtain an indication of 1 microvolt on the panel meter.

NOTE

Interaction will also occur between the PEAK control and PK-1 potentiometer adjustments. Adjust the two controls together until the desired indication is obtained.

5.4.4 Remote Meter Adjustment

When a remote meter is connected to the Y-OUTPUT receptacle, J121, its internal resistance must be adjusted to match that of the panel meter, M101, if optimum accuracy is to be obtained for the remote readings. A potentiometer, R239, is provided in the RFI Meter for this remote meter resistance adjustment. This adjustment is made after the meter scale tracking adjustments of paragraph 5.4.3, and is performed as follows:

a) Remove the RFI Meter from the case, as described in paragraph 5.2.3.

b) Set the operating controls as follows:

POWER switch	To OFF position
FUNCTION switch	To FI position
ATTENUATOR switch	To 20 dB position
TUNING control	To any position
CAL control	As called for
BAND switch	To any position
AGC switch	To ON position

c) Connect the remote meter to the Y-OUTPUT receptacle on the front panel.

d) Check that the pointers on both the front panel meter and the remote meter are exactly at mechanical zero: If not, correct by adjusting the screw on the front of the meter case.

e) Connect the 50-ohm output of the Signal Generator to the RF INPUT receptacle of the RFI Meter and set the POWER switch to the ON position.

f) Tune the RFI Meter and Signal Generator to exactly the same frequency and adjust the generator output level to 1000 microvolts.

g) Adjust the CAL control to provide a full-scale indication on the panel meter (100 microvolts).

h) Adjust R239 until the remote meter indication is exactly 100 microvolts.

5.4.5 Power Supply Adjustments

The voltage regulator output is adjusted at the factory to plus 12, ±0.1 volts. The regulator circuit is temperature compensated, and in normal use no change in the output voltage should occur. The battery charging current depends primarily on the battery voltage, however, it will be slightly greater in the CHARGE position of the POWER switch, than in the ON position. The maximum charging current for a fully discharged battery is approximately 130 milliamperes with the RFI Meter ON, and approximately 150 milliamperes with the RFI Meter OFF. The trickle charge currents for a fully charged battery are approximately 40 and 60 milliamperes, respectively. Under these conditions, the total charging time is approximately 30 hours in CHARGE, and 44 hours with the RFI Meter ON.

5.4.5.1 Voltage Regulator Adjustment - The voltage regulator output is adjusted as follows:

a) Remove the RFI Meter from the case, as described in paragraph 5.2.3.

b) Connect a DC VTVM between the plus 12 volt terminal (#1) in the IF section and ground.

c) Set the POWER switch to the ON position.

d) Adjust potentiometer R324 (located on the power supply board, Z200) to obtain plus 12, ±0.1 volts on the VTVM.

5.4.5.2 Charging Regulator Adjustment - If the observed battery charging time differs appreciably from those given in paragraph 5.4.5, the charging regulator may be adjusted as follows:

a) Remove the RFI Meter from the case, as described in paragraph 5.2.3.

b) Connect a DC VTVM between test point "E" (plus) on the power supply board, Z200, and ground.

c) Set the POWER switch to the CHARGE position.

d) Note the voltage indicated on the front panel BATTERY meter, and enter Table 5-4 with this figure and obtain the test point "E" voltage.

e) Observing the VTVM, adjust R318 (located on the power supply board, Z200) until the VTVM indicates the correct voltage for the battery level obtained in step "d".

NOTE

If the voltage at test point "E" is greater than indicated in Table 5-4, the charging time will be longer than specificed. Similarly, if the voltage is less, the charging time will be decreased.

Table 5-4. Battery Voltage vs. Charging Voltage

Battery (Volts)	Test Point "E" (Volts)
15.0	0.0
16.0	1.0
16.2	2.0
16.4	3.5
16.6	5.5
16.8	8.0

5.5 RECOMMENDED SERVICING PROCEDURES

5.5.1 General Precautions

Observe the following general precautions while troubleshooting, or replacing components within the RFI Meter:

a) Use extreme care in unsoldering solid-state components, small capacitors, or resistors.

b) Do not use a soldering iron rated at more than 37 watts; do not apply heat to the connection for more than a few seconds at a time.

c) Do not excessively bend or twist leads of transistors, diodes, or small capacitors and resistors; they break off easily.

d) Do not apply any DC potentials to input terminals.

e) Do not reverse battery connections; serious damage will result.

5.5.2 Printed Circuit Boards

Printed circuit boards consist of an insulating base (lamination), conductors (foil), feedthrough couplings, and components. The lamination is the structural part of the circuit board, and supports and positions the components. As most laminations are thin, 1/16-inch or less, they are very fragile and must be handled with care.

The first step in servicing a printed circuit board is to examine the board carefully with a strong magnifying glass. Such an examination may reveal physical damage to the lamination, foil, components, or leads.

Should examination reveal a broken foil, it is usually more practical to repair the foil than to replace the entire circuit board. If the break is large, place a short length of copper wire across the break and solder the ends to the broken foil. If the break is small, try flowing solder across the break. Do not apply excess heat, or allow solder to flow to other parts of the foil.

5.5.2.1 Removal of Wires or Components - When removing wires or componets from a printed circuit board, observe the following precautions:

a) Use a soldering aid for manipulating wires.

b) Use heatsinks to protect nearby parts.

c) Heat Connections only until wires loosen.

d) Remove wires quickly (but carefully).

e) Remove excess solder before it hardens.

5.5.2.2 Installation or Mounting of Components - When install- or mounting components on a printed circuit board, observe the following precautions:

a) Inspect the board to verify that it is clean and dry.

b) Install heatsinks to protect components.

c) Trim component leads to the approximate length required.

d) Place the components in the correct mounting position.

e) Insert the component leads through the mounting holes in the board (or wrap the leads around mounting terminals).

f) Solder the leads in place. Use sufficient heat to assure a good soldering joint, but be careful to avoid excessive heat.

g) Trim the leads close to the solder joint on the other side of the board.

h) Clean excess solder and rosin from all connections.

i) Remove heatsinks.

5.5.3 Transistor Testing

5.5.3.1 Preferred Method - If it is suspected that a particular transistor is defective, either check the transistor in a commercial transistor checker, or replace it with one of known quality.

5.5.3.2 Ohmmeter Method - If neither a transistor checker nor replacement transistor are available, the suspected transistor may be given a simple test with an ohmmeter.

WARNING

The ohmmeter must not have a higher potential than 4.5 volts DC, or damage may occur.

In checking a transistor with an ohmmeter, the transistor is treated as two separate semiconductor diodes having a common junction . In a good transistor, the diodes will have different forward and inverse resistances, depending upon the polarity of the DC voltage applied by the ohmmeter. When the anode of the diode is made positive with respect to the cathode, the forward resistance should be low. Conversely, when the anode is made negative with respect to the cathode, the inverse resistance should be high.

The greater the ratio of the inverse resistance to the forward resistance, the better the transistor. This ratio should be at least 10:1 or greater, in high quality, low-leakage transistors. A transistor is defective, and must be replaced if the forward resistance of either diode is high, if the inverse resistance of either diode is low, or if the ratio of the inverse resistance to the forward resistance is significantly lower than 10:1.

6.1 INTRODUCTION

This Section contains a tabulated listing of all electrical components of the NM-25T. Figures 6-1 thru 6-12 illustrate component locations within the unit, and also on the various sub-assemblies, and plug-in circuit boards. Reference designators are assigned to each replacable part, indicating the type of part; i.e., resistor, capacitor, transistor, etc.

To locate a particular component, proceed as follows:

a) Refer to the schematic diagram for the proper reference designator and sub-assembly/ or circuit board.

b) Refer to the appropriate illustration, Figure 6-1 thru 6-12, to locate the component.

c) Refer to the tabulated parts list for a complete description of the desired component.

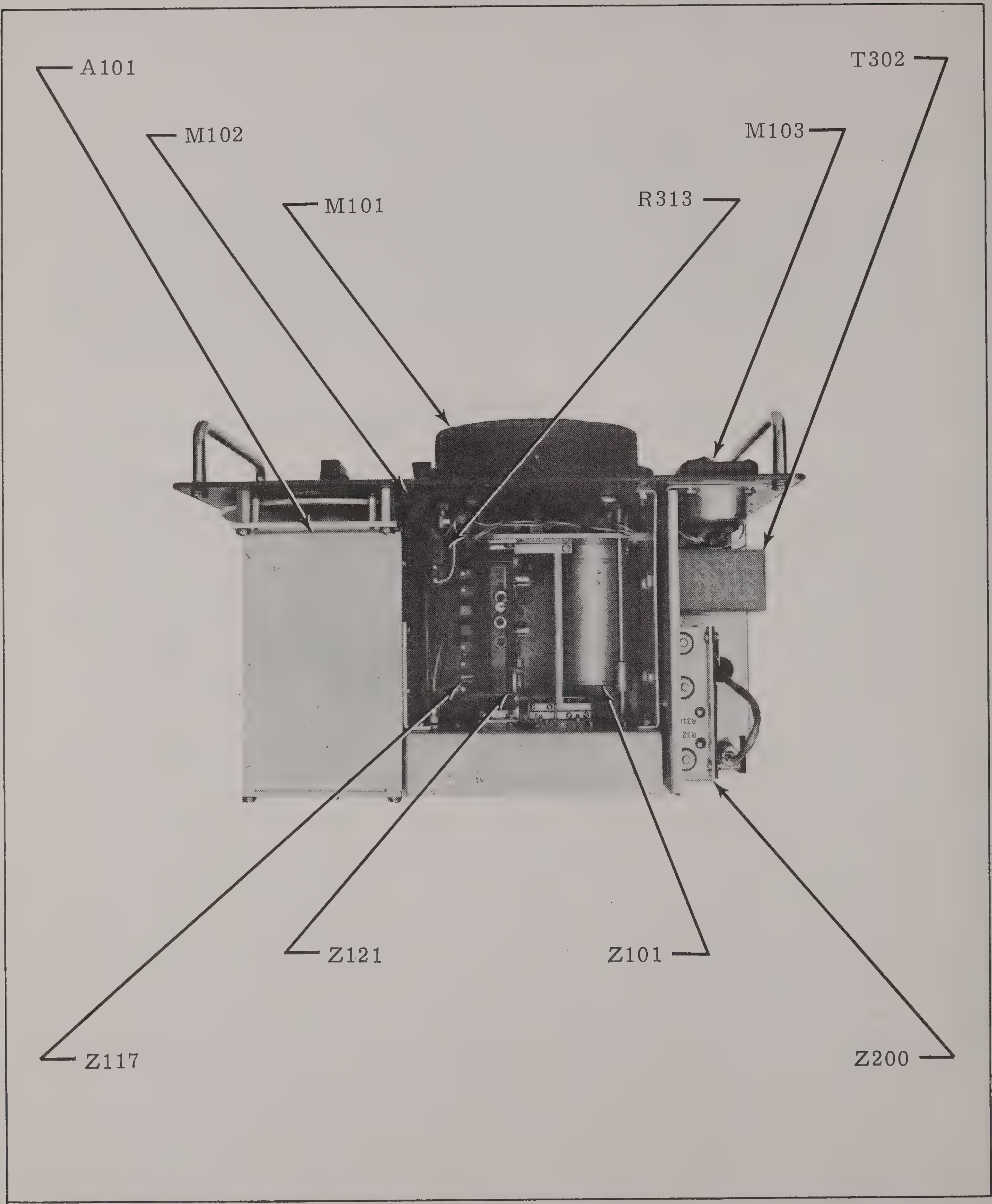


Figure 6-1. Component Location - Top View of RFI Meter

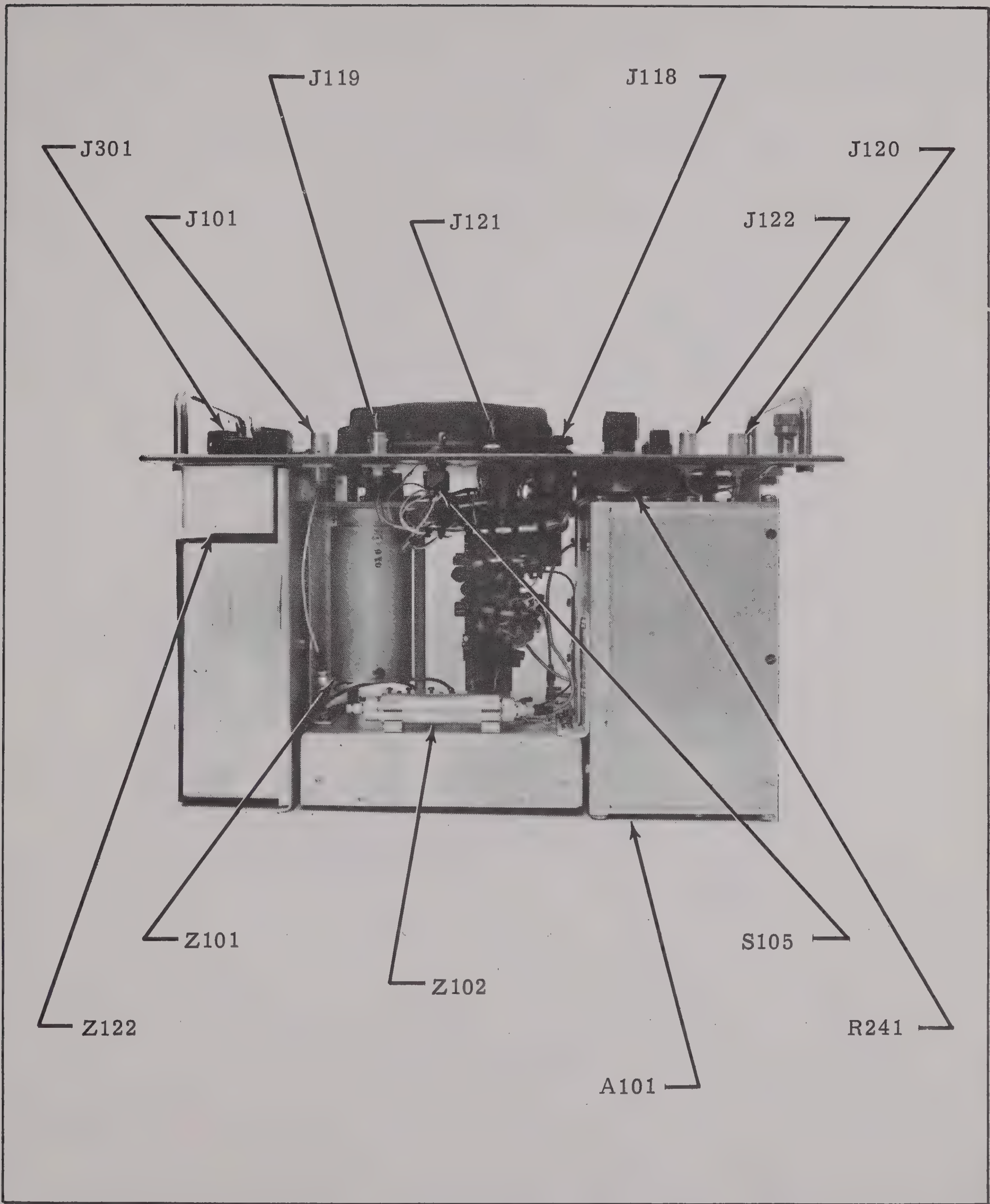


Figure 6-2. Component Location - Bottom View of RFI Meter

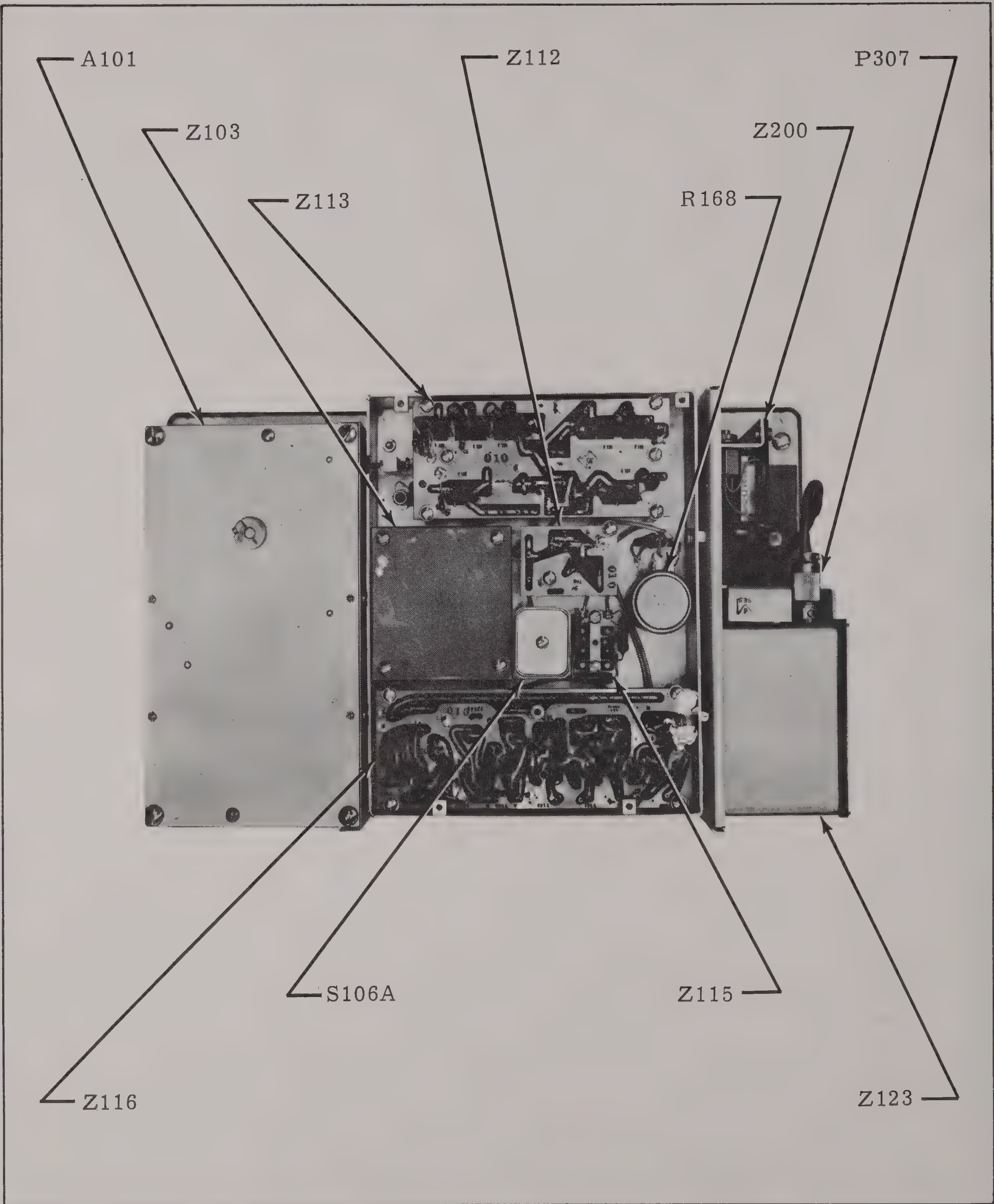


Figure 6-3. Component Location - Rear View of RFI Meter

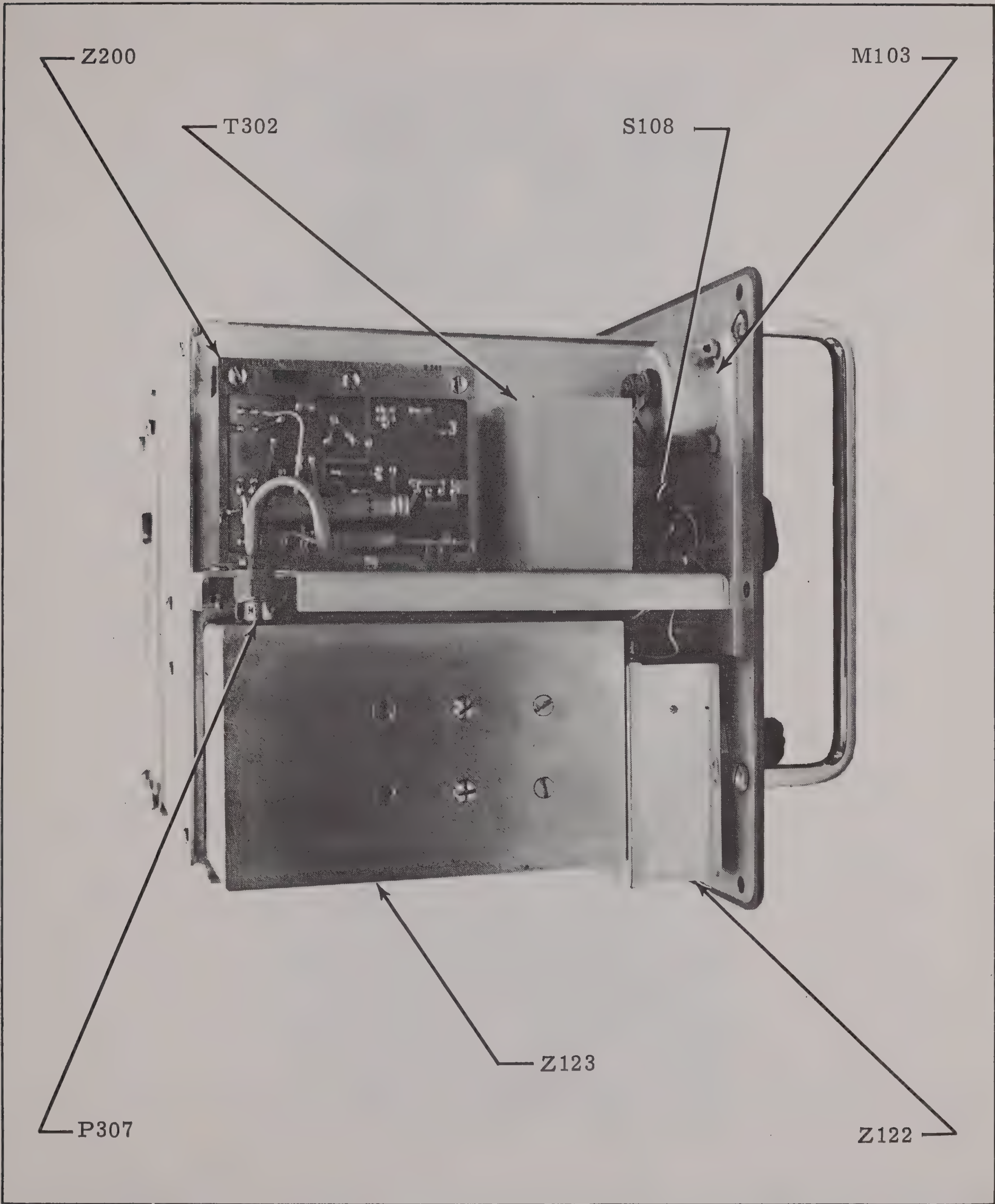


Figure 6-4. Component Location - End View of RFI Meter

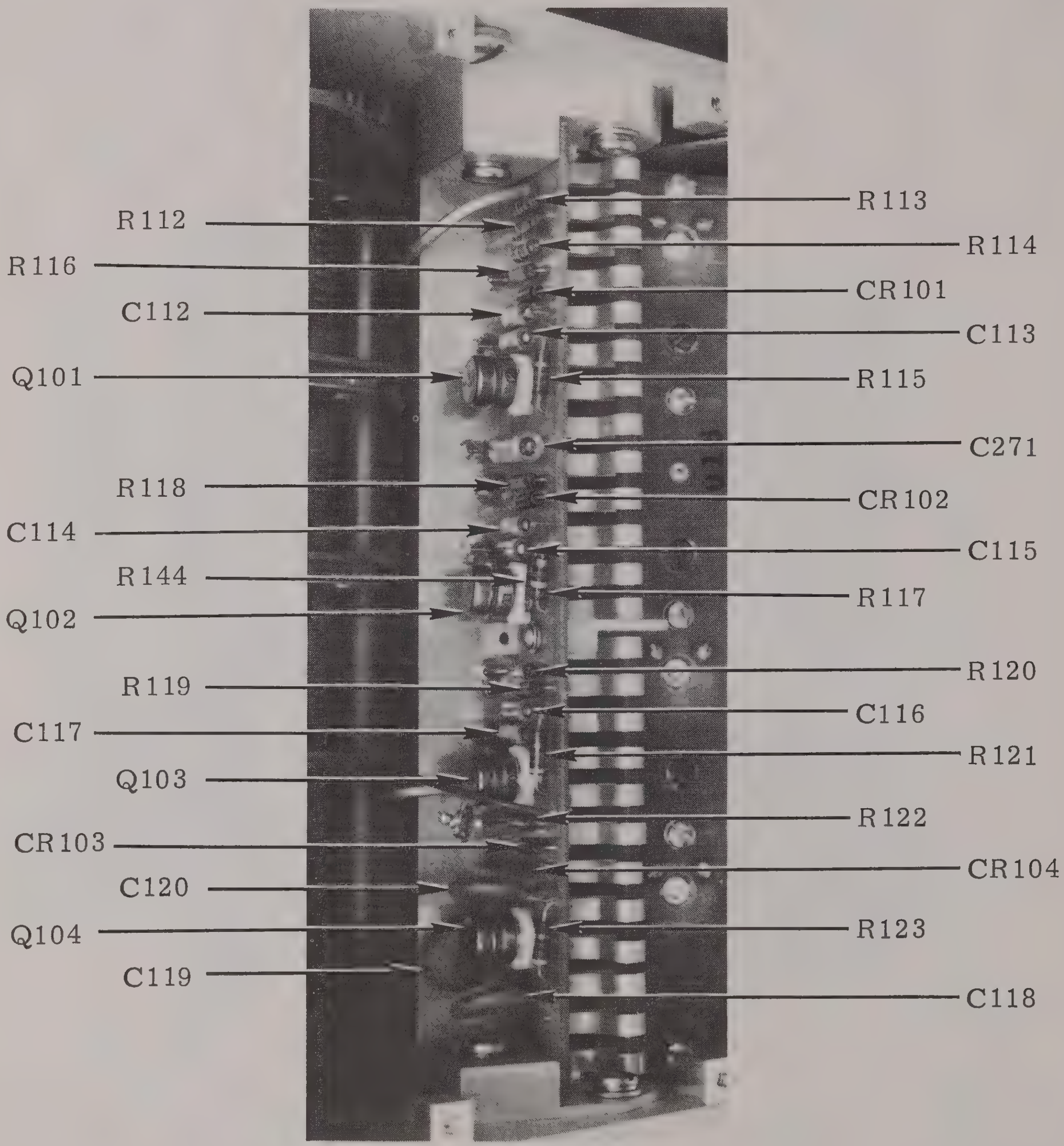


Figure 6-5. Component Location - RF Stages (Part of A101)

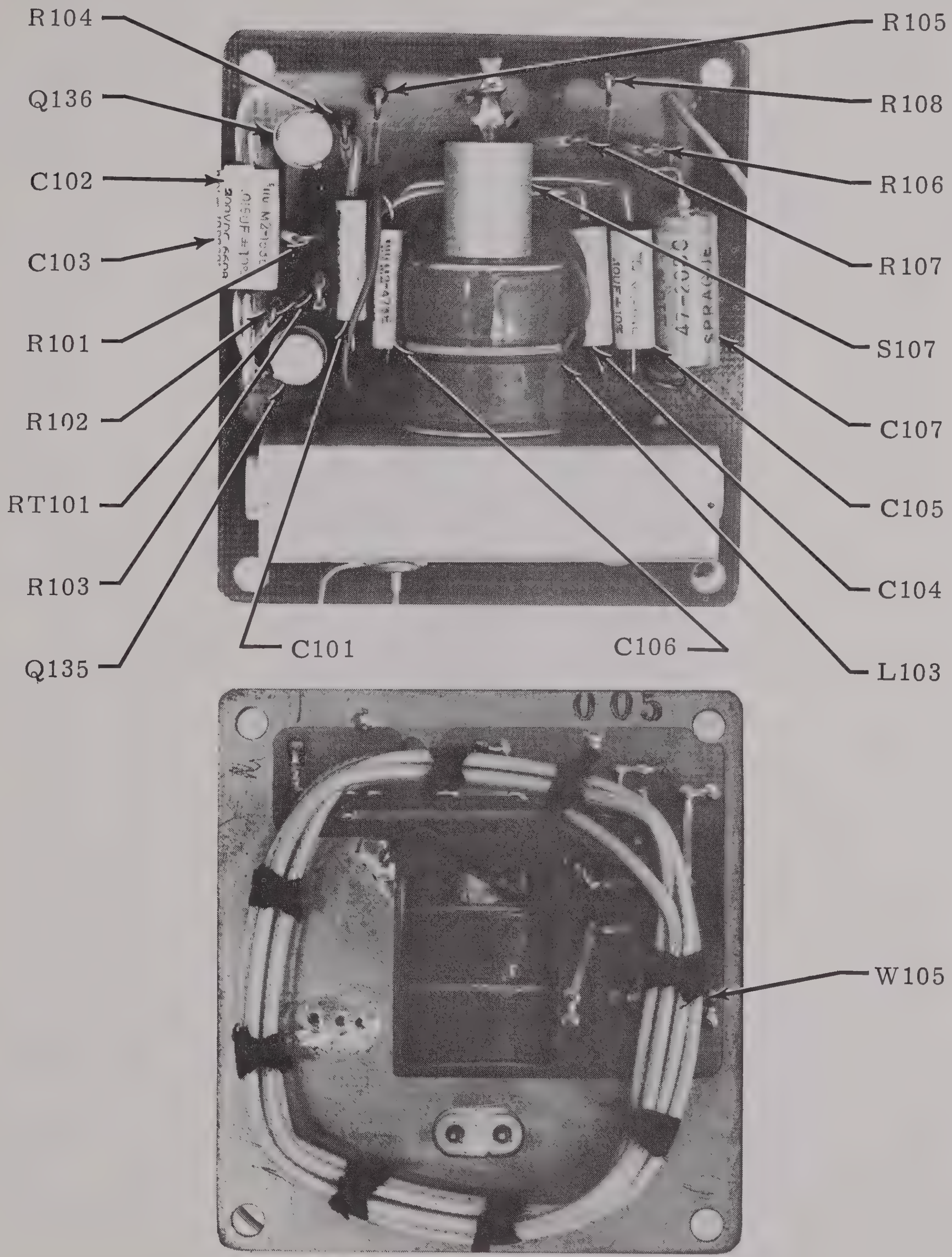


Figure 6-6. Component Location - Impulse Generator, Z103

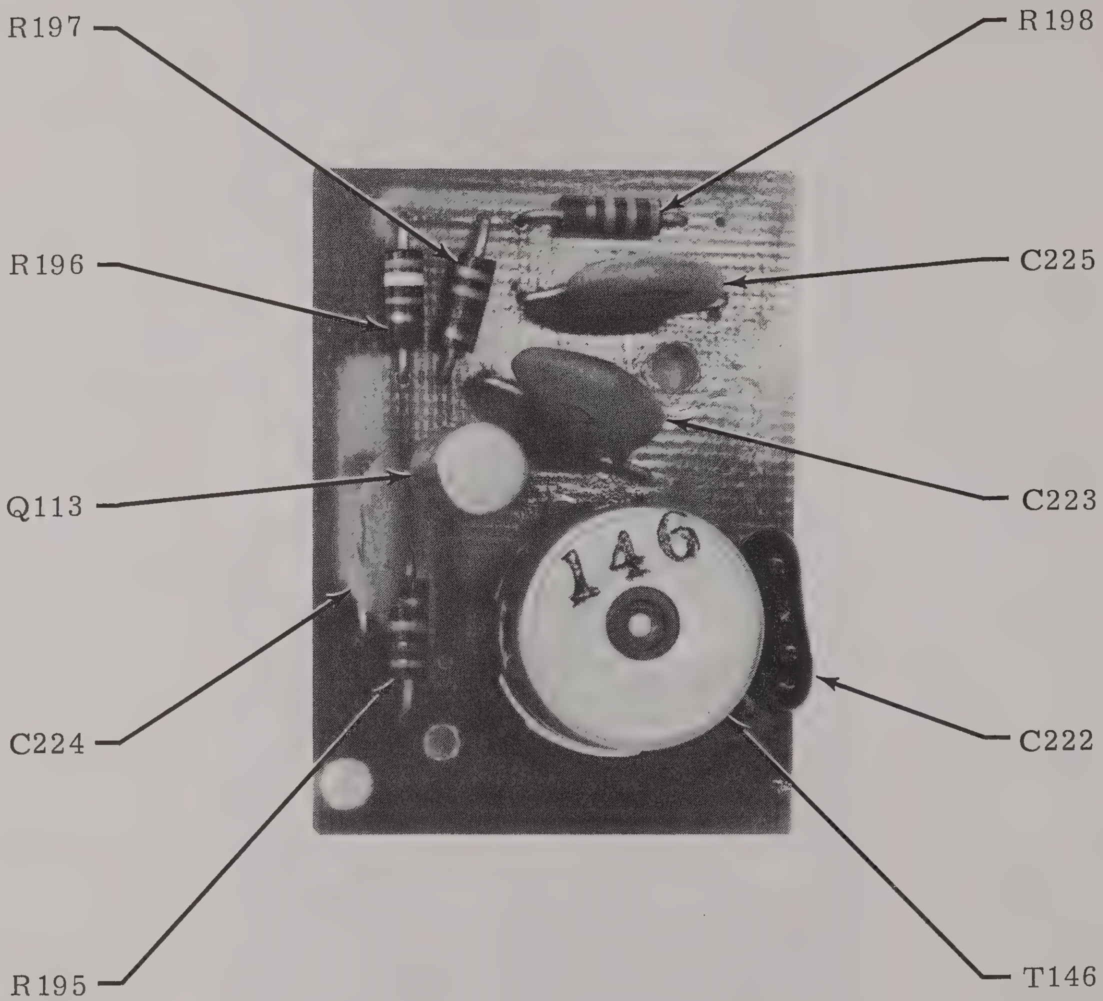
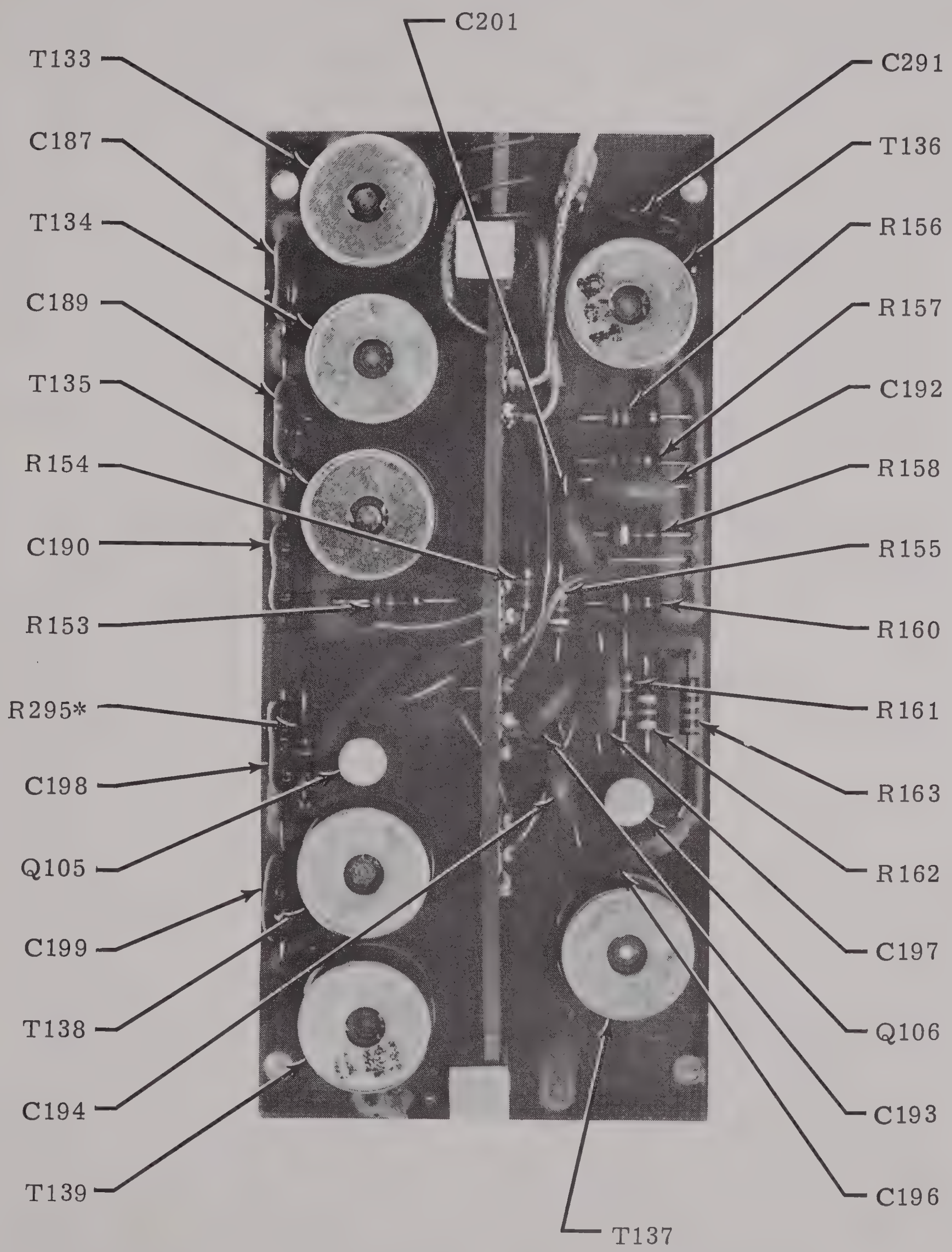


Figure 6-7. Component Location - Beat Frequency Oscillator, Z112



*VALUE AND LOCATION SELECTED IN FINAL TEST

Figure 6-8. Component Location - IF Converter, Z113 (Sheet 1 of 2)

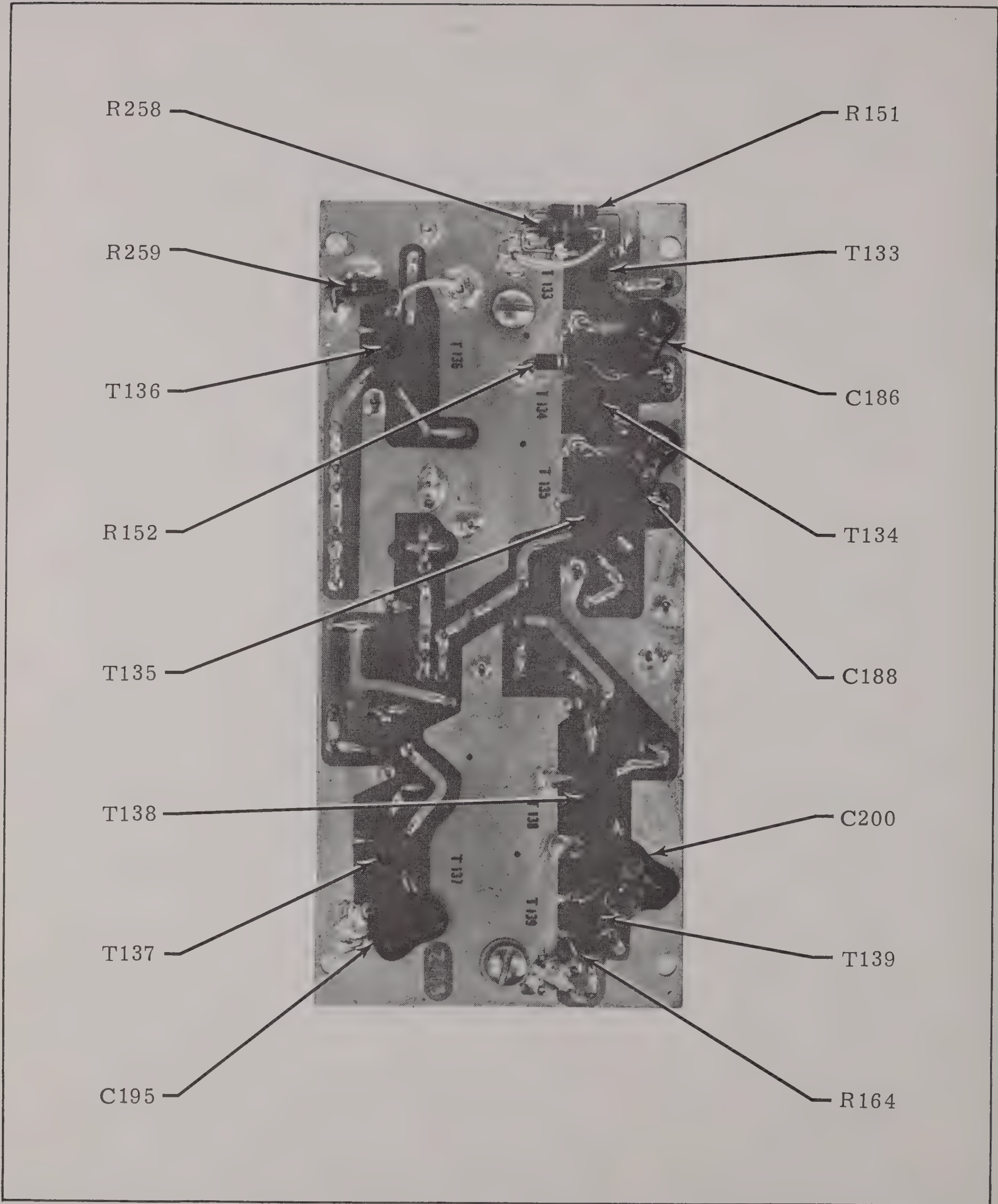


Figure 6-8. Component Location - IF Converter, Z113 (Sheet 2 of 2)

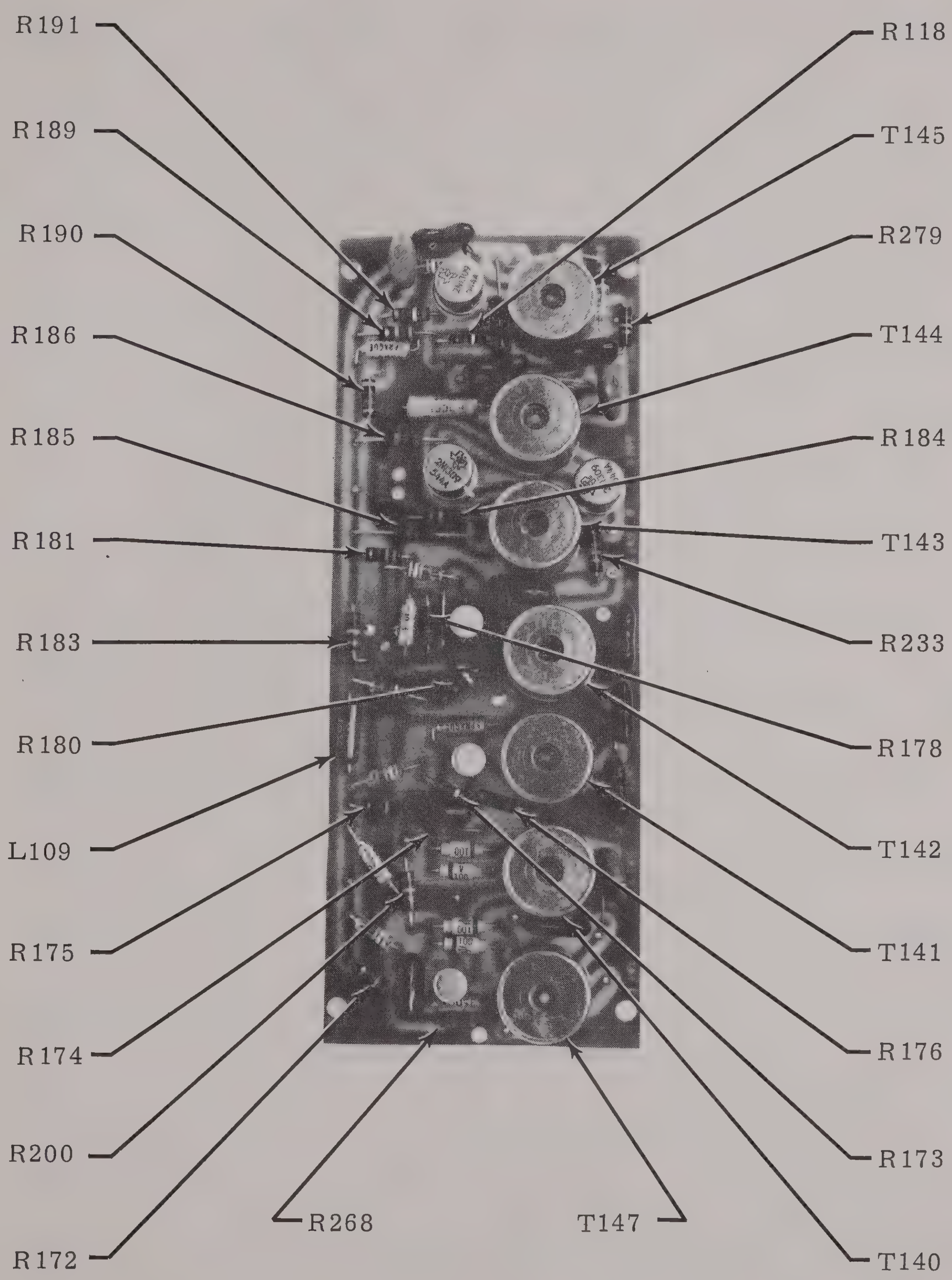


Figure 6-9. Component Location - Main IF Amplifier, Z116 (Sheet 1 of 3)

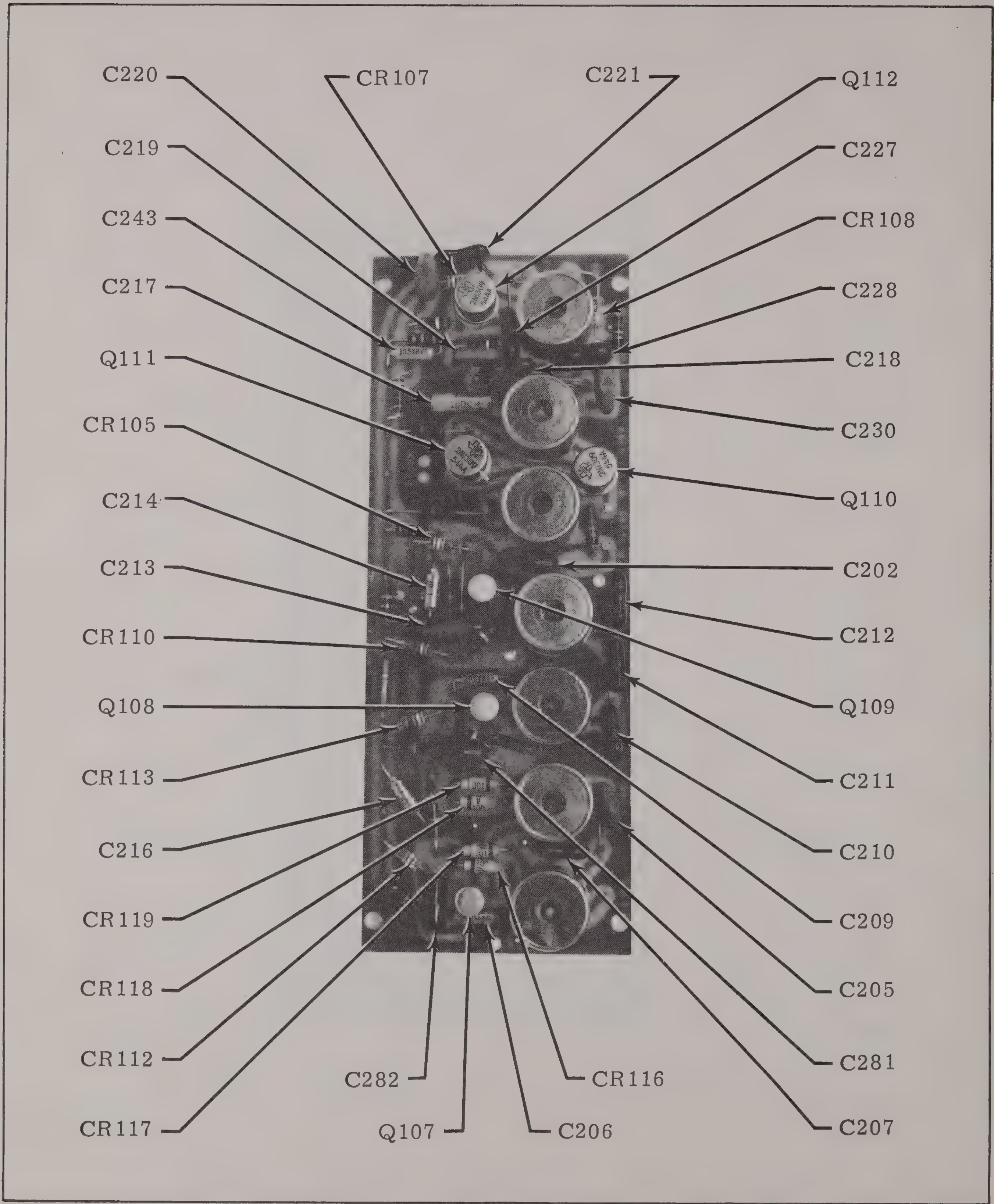
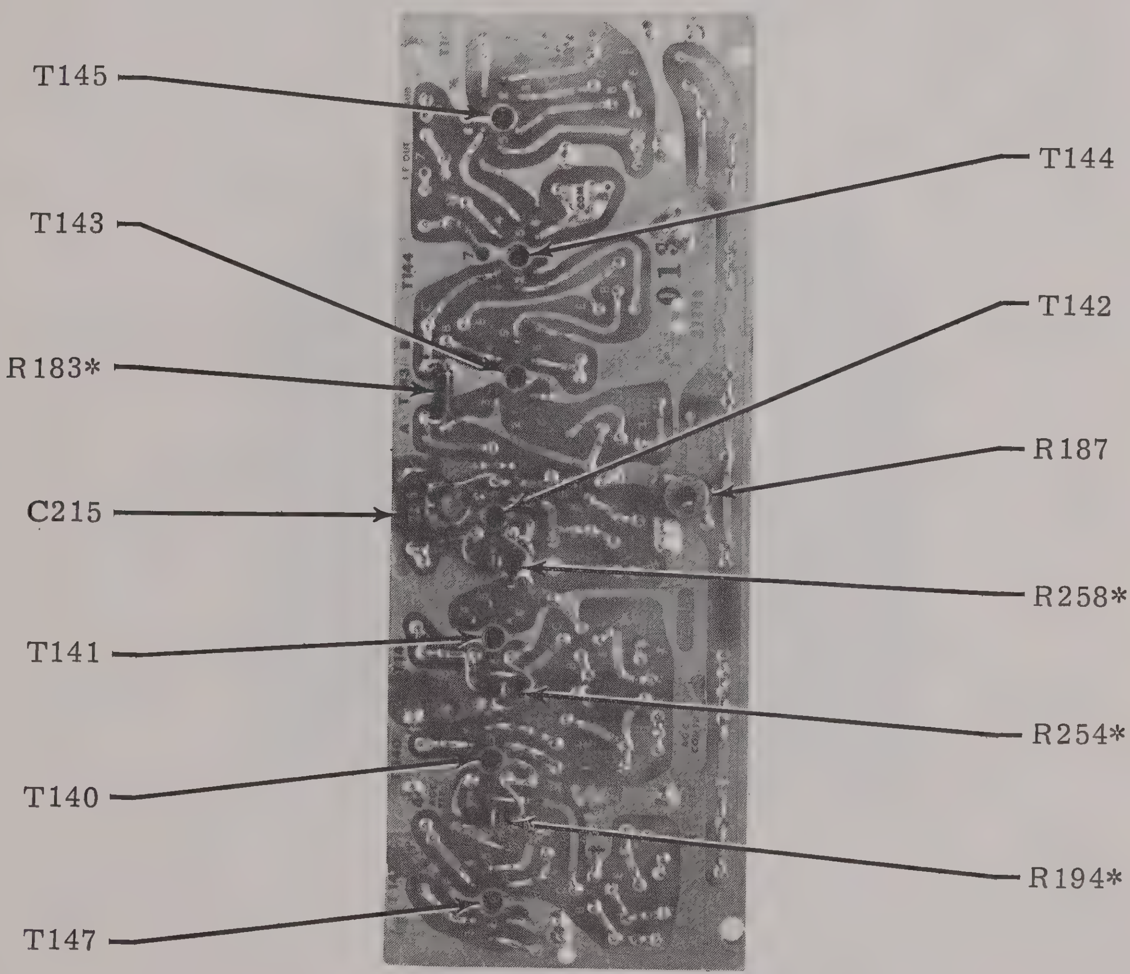


Figure 6-9. Component Location - Main IF Amplifier, Z116 (Sheet 2 of 3)



*MAY OR MAY NOT BE USED - SELECTED IN FINAL TEST

Figure 6-9. Component Location - Main IF Amplifier, Z116 (Sheet 3 of 3)

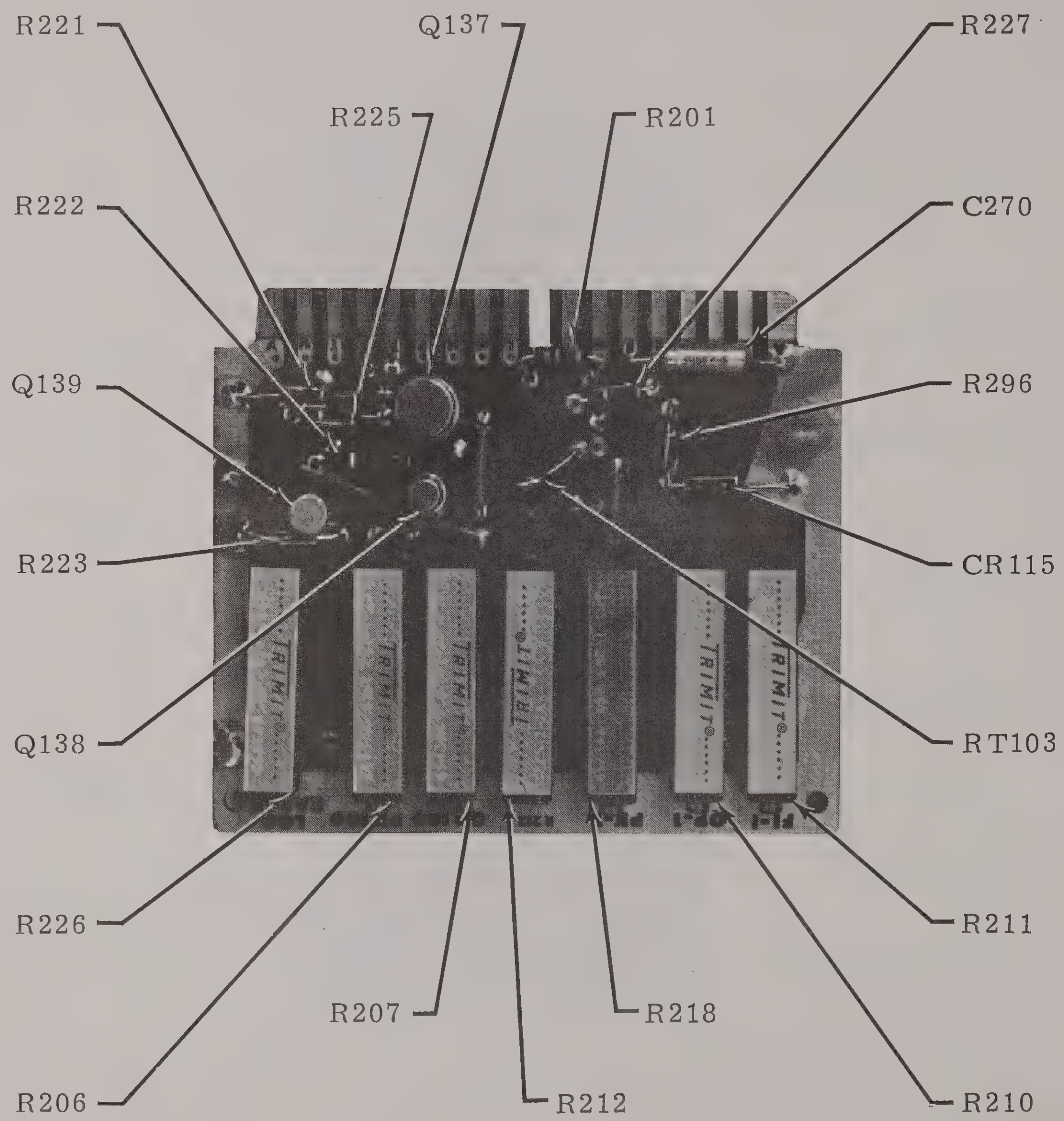


Figure 6-10. Component Location - Metering and Weighting Board, Z117

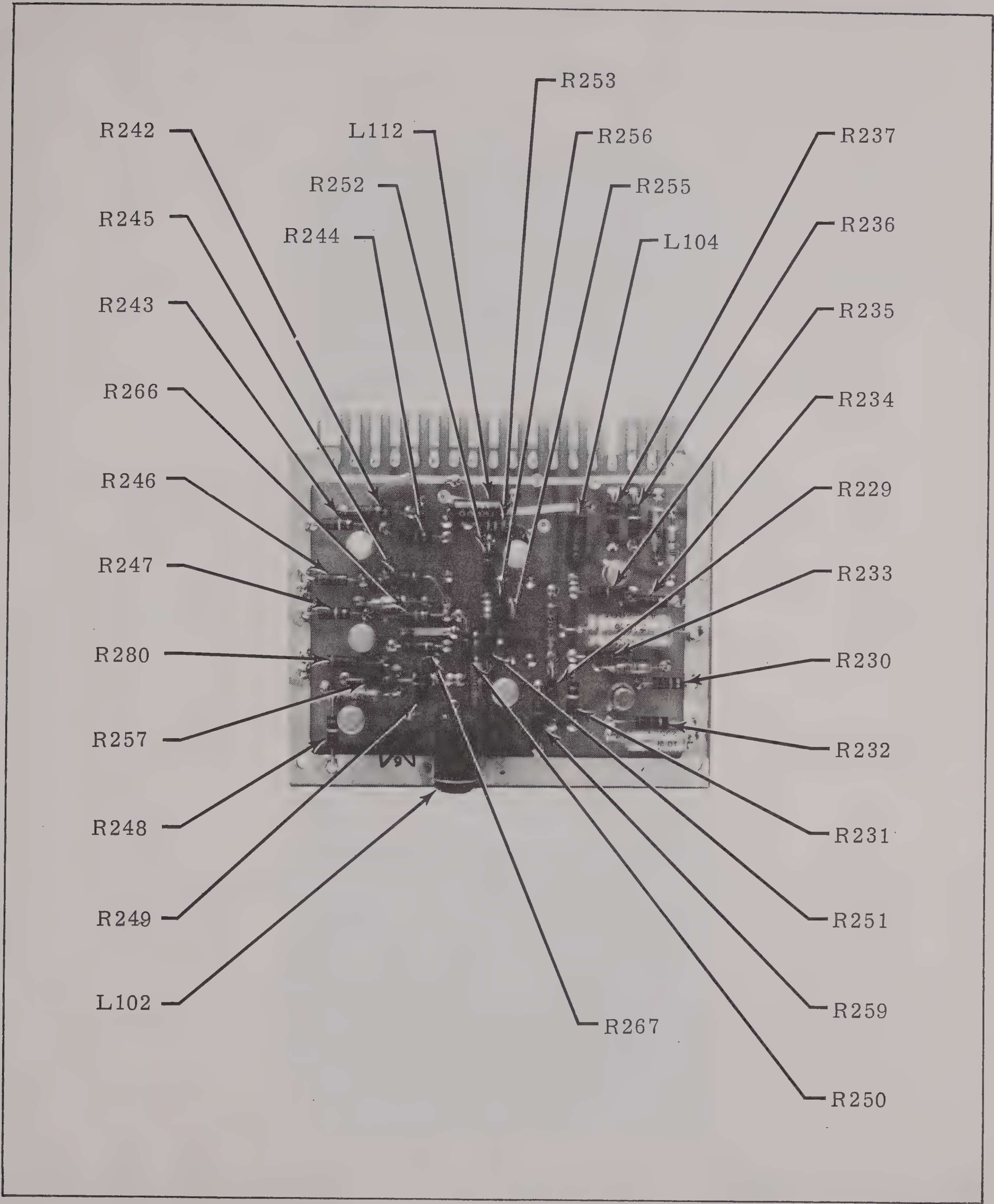
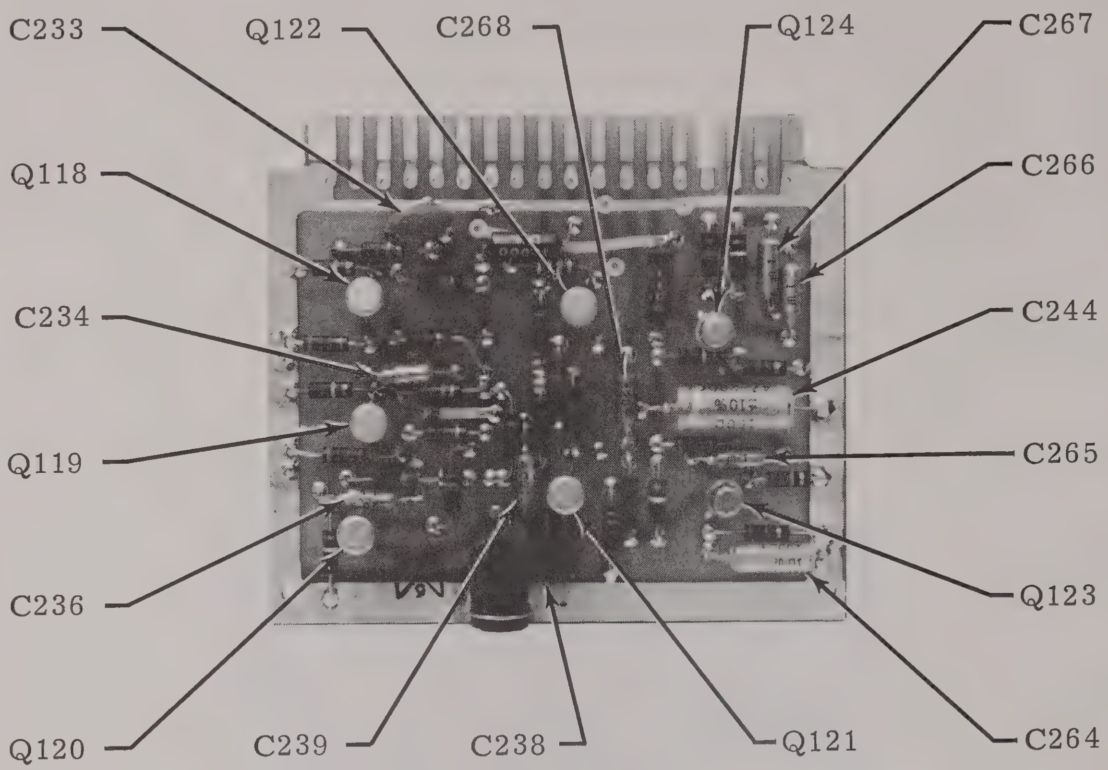


Figure 6-11. Component Location - Audio Amplifier, Z121 (Sheet 1 of 2)



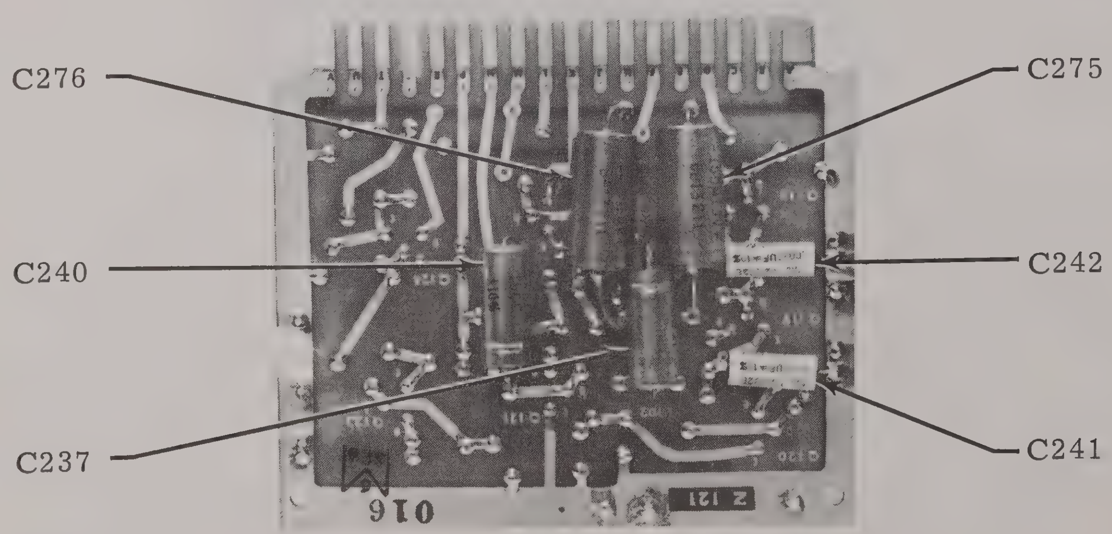


Figure 6-11. Component Location - Audio Amplifier, Z121 (Sheet 2 of 2)

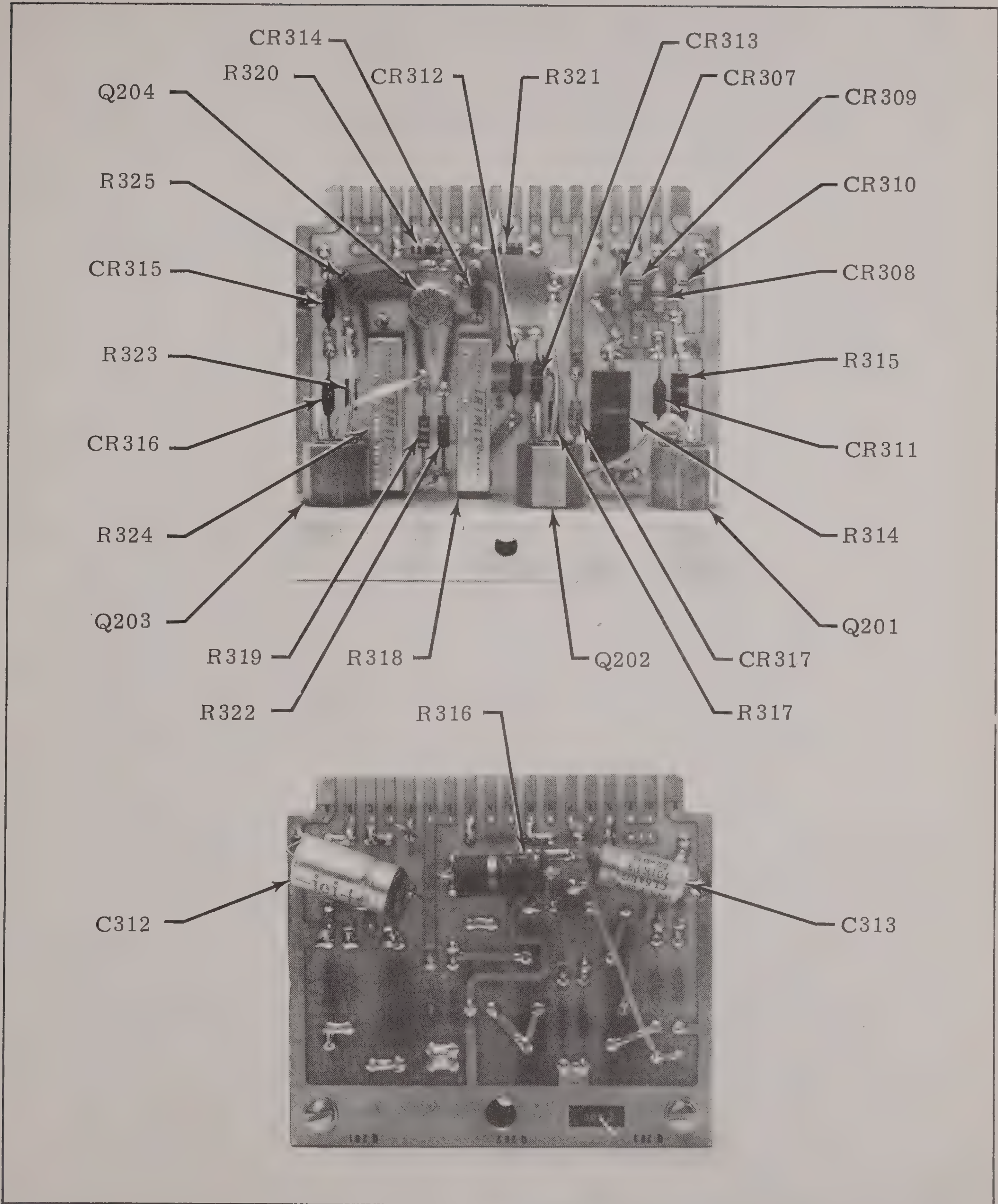


Figure 6-12. Component Location - Power Supply Regulator, Z200

SYMBOL	DESCRIPTION
C101	CAPACITOR, FIXED, PLASTIC; 15,000 pf; ±10%; 200 vdcw; Electron Products No. M2-153E; Stoddart No. 11554
C102	Same as C101
C103	CAPACITOR, FIXED, PLASTIC; 6,800 pf; ±10%; 200 vdcw; Electron Products No. ME-682E; Stoddart No. 11558
C104	CAPACITOR, FIXED, PLASTIC; 100,000 pf; ±10%; 200 vdcw Electron Products No. M2-104E; Stoddart No. 11557
C105	Same as C104
C106	CAPACITOR, FIXED, PLASTIC; 47,000 pf; ±10%; 200 vdcw; Electron Products No. M2-473E; Stoddart No. 11556
C107	CAPACITOR, FIXED, ELECTROLYTIC; 47 mfd; ±10%; 15 vdcw; Sprague No. 150D476X9020R2; Stoddart No. 11555
C108	CAPACITOR, FIXED, MICA; 510 pf; ±5%; 500 vdcw; Type DM15F511J; Stoddart No. 11472-511
C109	CAPACITOR, FIXED, MICA; 220 pf; ±5%; 500 vdcw; Type DM15F221J; Stoddart No. 11472-221
C110	CAPACITOR, FIXED, MICA; 110 pf; ±5%; 500 vdcw; Type DM15F111J; Stoddart No. 11472-111

SYMBOL	DESCRIPTION
C111A	CAPACITOR, VARIABLE, AIR DIELECTRIC; Section A of four sections; Model No. 419, Type K, 210 uuf; Stoddart No. 11652
C111B	Same as C111A
C111C	Same as C111A
C111D	Same as C111A
C112	CAPACITOR, FIXED, ELECTROLYTIC; 1 mfd; 35 vdcw; Sprague Number 150D105X0035A2; Stoddart No. 11782
C113	Same as C112
C114	Same as C112
C115	Same as C112
C116	Same as C112
C117	Same as C112
C118	CAPACITOR, FIXED, CERAMIC; 20,000 pf; 150 vdcw; Disc Type Centralab No. DDM-203; Stoddart No. 18329
C119	Same as C118
C120	Same as C118
C121	CAPACITOR, VARIABLE, AIR DIELECTRIC; 1.8 to 13 pf; E. F. Johnson No. 189-6; Stoddart No. 11999
C122	CAPACITOR, FIXED MICA; 39 pf; ±5%; 500 vdcw; Type DM10C390J; Stoddart No. 11653-390

SYMBOL	DESCRIPTION
C123	CAPACITOR, FIXED, MICA; 620 pf; ±5%; 500 vdcw; Type DM15F621J; Stoddart No. 11308-621
C124	Same as C123
C125	Same as C118
C126	CAPACITOR, FIXED, MICA; 24 pf; ±5%; 500 vdcw; Type DM10C240J; Stoddart No. 11653-240
C127	Same as C121
C128	CAPACITOR, FIXED, MICA; 51 pf; ±5%; 500 vdcw; Type DM15E510J; Stoddart No. 11472-510
C129	Same as C121
C130	CAPACITOR, FIXED, MICA; 33 pf; ±1%; 500 vdcw; Type DM15E330F; Stoddart No. 11654-330
C131	Same as C121
C132	Same as C126
C133	CAPACITOR, FIXED, MICA; 300 pf; ±5%; 500 vdcw; Type DM15F301J; Stoddart No. 11472-301
C134	Same as C133
C135	Same as C118
C136	Same as C121

SYMBOL	DESCRIPTION
C137	CAPACITOR, FIXED, MICA; 20 pf; ±5%; 500 vdcw; Type DM10C200J; Stoddart No. 11653-200
C138	CAPACITOR, FIXED, MICA; 47 pf; ±5%; 500 vdcw; Type DM15E470J; Stoddart No. 11750-470
C139	Same as C121
C140	CAPACITOR, FIXED, MICA; 56 pf; ±1%; 500 vdcw; Type DM15E560F; Stoddart No. 11654-560
C141	Same as C121
C142	Same as C137
C143	Same as C121
C144	Same as C137
C145	Same as C121
C146	Same as C137
C147	CAPACITOR, FIXED, MICA; 30 pf; ±5%; 500 vdcw; Type DM10E300J; Stoddart No. 11653-300
C148	Same as C121
C149	CAPACITOR, FIXED, MICA; 330 pf; ±1%; 500 vdcw; Type DM15F331F; Stoddart No. 11654-331
C150	Same as C121
C151	Same as C126
C152	Same as C121

SYMBOL	DESCRIPTION
C153	Same as C137
C154	Same as C121
C155	Same as C137
C156	Same as C126
C157	Same as C121
C158	CAPACITOR, FIXED, MICA; 620 pf; ±1%; 500 vdcw; Type DM15F621F; Stoddart No. 11654-621
C159	Same as C121
C160	Same as C147
C161	Same as C121
C162	Same as C137
C163	Same as C121
C164	CAPACITOR, FIXED, MICA; 3 pf; ±5%; 500 vdcw; Type DM10C030J; Stoddart No. 11750-3R0
C165	Same as C137
C166	Same as C137
C167	Same as C121
C168	CAPACITOR, FIXED, MICA; 1,200 pf; ±1%; 500 vdcw; Type No. DM15F122F; Stoddart No. 11654-122
C169	Same as C121
C170	Same as C147
C171	Same as C121

SYMBOL	DESCRIPTION
C172	CAPACITOR, FIXED, MICA; 15 pf; ±5%; 500 vdcw; Type DM15C150J; Stoddart No. 11472-150
C173	CAPACITOR, FIXED, MICA; 100 pf; ±5%; 500 vdcw; Type DM15F101J; Stoddart No. 11472-101
C174	Same as C121
C175	Same as C147
C176	Same as C147
C177	Same as C121
C178	CAPACITOR, FIXED, MICA; 680 pf; ±1%; 500 vdcw Type DM15F681F; Stoddart No. 11654-681
C179	Same as C121
C180	CAPACITOR, FIXED, MICA; 27 pf; ±5%; 500 vdcw; Type DM10E270J; Stoddart No. 11653-270
C181	Same as C121
C182	Same as C172
C183	Same as C180
C184	Same as C121
C185	Same as C147
C186	CAPACITOR, FIXED, MICA; 270 pf; ±5%; Type DM15F271J; Stoddart No. 11308-271

SYMBOL	DESCRIPTION
C187	CAPACITOR, FIXED, MICA; 2 pf; $\pm5\%$; Type CM05C020J; Stoddart No. 11308-020
C188	Same as C186
C189	Same as C187
C190	Same as C186
C191	Same as C186
C192	Same as C118
C193	Same as C118
C194	Same as C118
C195	Same as C186
C196	Same as C118
C197	Same as C118
C198	Same as C186
C199	CAPACITOR, FIXED, MICA; 3 pf; $\pm5\%$; 300 vdcw; Type DM15030J Stoddart No. 11308-030
C200	Same as C186
C201	Same as C118
C202	Same as C149
C203	Same as C118
C204	Not Used
C205	Same as C118
C206	Same as C112
C207	Same as C186
C208	Same as C112
C209	Same as C112

SYMBOL	DESCRIPTION
C210	Same as C186
C211	Same as C199
C212	Same as C186
C213	Same as C118
C214	Same as C112
C215	Same as C186
C216	Same as C112
C217	CAPACITOR, FIXED, ELECTROLYTIC; 33 mfd; $\pm20\%$; 15 vdcw; Type Sprague 150D336X0010B2; Stoddart No. 18613-033
C218	Same as C186
C219	Same as C118
C220	Same as C118
C221	CAPACITOR, FIXED, MICA; 82 pf; $\pm5\%$; 500 vdcw; Type DM15F820J; Stoddart No. 11308-820
C222	Same as C186
C223	Same as C118
C224	Same as C118
C225	Same as C118
C226	Not Used
C227	CAPACITOR, FIXED, MICA; 100 pf; $\pm5\%$; 500 vdcw; Type DM15F101J; Stoddart No. 11308-101

SYMBOL	DESCRIPTION
C228	CAPACITOR, FIXED, MICA; 430 pf; ±5%; 500 vdcw; Type DM15F431J; Stoddart No. 11308-431
C229	CAPACITOR, FIXED, MICA; 220 pf; ±10%; 500 vdcw; Type DM15F221K; Stoddart No. 11790-221
C230	Same as C118
C231	CAPACITOR, FIXED, PLASTIC; 100,000 pf; ±20%; 200 vdcw; WESCAP; Stoddart No. 10678
C232	CAPACITOR, FIXED; 180 mfd; 6 vdcw; Sprague 150D187X9006R2; Stoddart No. 11737
C233	Same as C118
C234	Same as C112
C235	Same as C186
C236	Same as C112
C237	Same as C107
C238	CAPACITOR, FIXED, MICA; 680 pf; ±5%; 500 vdcw; Type DM15F681J; Stoddart No. 11472-681
C239	Same as C112
C240	CAPACITOR, FIXED, ELECTROLYTIC; 100 mfd; ±5%; 10 vdcw; Sprague No. 150D107X9010R2; Stoddart No. 11791-101

SYMBOL	DESCRIPTION
C241	CAPACITOR, FIXED, PLASTIC; 0.0033 mfd; ±10%; 200 vdcw; Mylar; Electron Products No. M2-332E
C242	Same as C241
C243	Same as C112
C244	Same as C107
C245 thru C247	Not used
C248	Same as C147
C249	Same as C121
C250	CAPACITOR, FIXED, MICA; 1,200 pf; ±1%; 500 vdcw Type DM15F122F; Stoddart No. 11643-122
C251	Same as C121
C252	CAPACITOR, FIXED, MICA; 36 pf; ±5%; 500 vdcw; Type DM10E360J; Stoddart No. 11653-360
C253	Same as C121
C254	Same as C149
C255	Same as C118
C256	Same as C121
C257	Same as C130
C258	Same as C252
C259	Same as C121

SYMBOL	DESCRIPTION
C260	CAPACITOR, FIXED, MICA; 2,500 pf; ±1%; 500 vdcw; Type DM15F252F; Stoddart No. 11643-252
C261	Same as C118
C262	Same as C118
C263	Same as C112
C264	Same as C107
C265	Same as C112
C266	Same as C112
C267	Same as C112
C268	Not used
C269	Not used
C270	Same as C217
C271	CAPACITOR, FIXED, ELECTROLYTIC; 10 mfd; 15 vdcw; Sprague No. 150D106X9020B2; Stoddart No. 11722
C272 thru C274	Not used
C275	CAPACITOR, FIXED, ELECTROLYTIC; 150 mfd; 15 vdcw; Texas Instr. No. SCM157HP015A2; Stoddart No. 18518-151
C276	Same as C275
C277	CAPACITOR, FIXED, MICA; 56 pf; ±5%; 500 vdcw; Type DM15E560J; Stoddart No. 11147-560

SYMBOL	DESCRIPTION
C278	CAPACITOR, FIXED, MICA; 12 pf; ±5%; 500 vdcw; Type DM15F121J; Stoddart No. 11472-120
C279	CAPACITOR, FIXED, MICA; 10 pf; ±5%; 500 vdcw; Type DM150F100J; Stoddart No. 11472-100
C280	Same as C278
C281	CAPACITOR, FIXED, MICA; 1000 pf; ±5%; 500 vdcw; Type DM15F102J; Stoddart No. 11308-102
C282	Same as C281
C283 thru C301	Not used
C302	CAPACITOR, FIXED, CERAMIC; 10,000 pf; 1,500 vdcw; Style 811, Ceramicon; Erie Resistor Corporation; Stoddart No. 10369
C303	Same as C302
C304	CAPACITOR, FIXED, CERAMIC; 1,000 pf; GMV-0 + 100%; Feedthru, Allen Bradley Type FB2B-102W; Stoddart No. 11684
C305	Not Used
C306	Same as C302
C306	Same as C302
C307	Same as C302
C308	Same as C304

SYMBOL	DESCRIPTION
C309 thru C311	Not used
C312	CAPACITOR, FIXED, TANTALUM; 82 mfd; 50 vdcw; Fansteel SP314-20; Stoddart No. 18511
C313	CAPACITOR, FIXED, TANTALUM; 100 mfd; 25 vdcw; Fansteel SP210-20; Stoddart No. 18512
C314 thru C400	Not used
C499	Not used
CR101	SEMICONDUCTOR DEVICE, DIODE; Stabistor Silcon 0.65 v; Transitron Electronics, Type SG22; Stoddart No. 18521
CR102	Same as CR101
CR103	Same as CR101
CR104	Same as CR101
CR105	SEMICONDUCTOR DEVICE, DIODE; Germanium, Hytron Corporation, Type No. 1N498; Stoddart No.1N498
CR106	SEMICONDUCTOR DEVICE, DIODE; silcon, HMN 627 Hughes; Stoddart No. 18517
CR107	Same as CR105
CR108	Same as CR105
CR109	Not used
CR110	Same as CR105

SYMBOL	DESCRIPTION
CR111	Not used
CR112	Same as CR105
CR113	Same as CR105
CR114	Not used
CR115	SEMICONDUCTOR DEVICE, DIODE; Motorola No. 1N935A; Stoddart No. 1N935A
CR116	DIODE; Varicap (Supplied in Matched Pairs), Stoddart No. 18561
CR117	Same as CR116
CR118	Same as CR116
CR119	Same as CR116
CR120 thru CR306	Not used
CR307	SEMICONDUCTOR DEVICE, DIODE; Pacific Semiconductor PS405; Stoddart No. 18508
CR308	Same as CR307
CR309	Same as CR307
CR310	Same as CR307
CR311	SEMICONDUCTOR DEVICE, DIODE; Zener, Type No. 1N750A; Stoddart No. 1N750A
CR312	SEMICONDUCTOR DEVICE, DIODE; Zener, Stoddart No. 1N752A
CR313	SEMICONDUCTOR DEVICE, DIODE; Zener, Stoddart No. 1N759A

SYMBOL	DESCRIPTION
CR314	SEMICONDUCTOR DEVICE, DIODE; Zener, Stoddart No. 1N751A
CR315	SEMICONDUCTOR DEVICE, DIODE; Zener, Texas Instrument Type G130; Stoddart No. 18509
CR316	Same as CR315
CR317	Same as CR307
F301	FUSE, CARTRIDGE; 1/10 Amp. 125 v; Littlefuse, Inc., No. 3AG; Stoddart No. 18528
F302	Same as F301
J101	CONNECTOR RECEPTACLE; (Part of Cable Assembly W101)
J102	CONNECTOR RECEPTACLE; Microdot, Inc., No. 31-03 Stoddart No. 11726
J103	Same as J102
J104	POST BINDING; H. H. Eby Company, No. 6604 Stoddart No. 6604
J105 thru J110	Not used
J111	CONNECTOR RECEPTACLE; Microdot, Inc., No. 33-01 Stoddart No. 11748
J112	Same as J111
J113	CABLE ASSEMBLY R.F.; 50 Ohm Connector on one end of coaxial cable Stoddart No. 11675-5

SYMBOL	DESCRIPTION
J114 thru J117	Not used
J118	JACK, TELEPHONE; for two Connector Plugs; CMA No. JK-34A; Stoddart No. 10122
J119	CONNECTOR, RECEPTACLE; MIL Type UG-290A/U; BNC, Stoddart No. 10121
J120	Same as J119
J121	JACK, TELEPHONE; for three Conductor Plug, CBIM No. 2J1047A; Stoddart No. 10123
J122	Same as J119
J301	Not used
J302	Not used
J303	CONNECTOR, RECEPTACLE; three Contacts; three Male Connector mating ends; CED No. MS3102E-14S-7P; Stoddart No. 11180
J304	CONNECTOR, RECEPTACLE; 18 Contact,Strip, Viking Electronics No. 18/1AB5, Stoddart No. 18326
J305	Same as J304
J306	Same as J304
J307	CONNECTOR; two contact male, Viking No. VR2/4CE6; Stoddart No. 18325
L101	Not used

SYMBOL	DESCRIPTION
L102	COIL, RADIO FREQUENCY; 6HY inductor United Trans. Part No. DO-T26 Stoddart No. 11721
L103	COIL, RADIO FREQUENCY; Impulse Generator Coil Assembly; Stoddart No. 92046-1
L104	Same as L106
L105	COIL, RADIO FREQUENCY; Second RF Coil Assembly; Stoddart No. 93865-1
L106	COIL, RADIO FREQUENCY; 10 MH, Essex Electronics, Type WEE-DUCTOR 10,000; Stoddart No. 11719-103
L107	COIL, RADIO FREQUENCY; Second RF Coil Assembly; Stoddart No. 93870-1
L108	Not used
L109	COIL, RADIO FREQUENCY; 1.5 MH, Essex Electronics, Type WEE-DUCTOR 150,000; Stoddart No. 11719-152
L110	COIL, RADIO FREQUENCY; 560 uh, Essex Electronics, Type WEE-DUCTOR No. 10,000; Stoddart No. 11719-561
L111	Not Used
L112	Same as L106
L113	COIL, RADIO FREQUENCY; 220 uh, Essex Electronics Type, WEE-DUCTOR 10,000, Stoddart No. 11719-221

SYMBOL	DESCRIPTION
L114	COIL, RADIO FREQUENCY; 100 uh Essex Electronics Type, WEE-DUCTOR 10,000, Stoddart No. 11719-101
L115	COIL, RADIO FREQUENCY; 56 uh, Essex Electronics Type, WEE-DUCTOR 10,000, Stoddart No. 11719-560
L116	Not used
L117	COIL, RADIO FREQUENCY, 100 uh Essex Electronics Type, WEE-DUCTOR 10,000, Stoddart No. 11719-101
L118	COIL, RADIO FREQUENCY, 10 uh Essex Electronics Type, WEE-DUCTOR 10,000, Stoddart No. 11719-100
L119	COIL, RADIO FREQUENCY, 2.7 uh Essex Electronics Type, WEE-DUCTOR 10,000, Stoddart No. 11719-2R7
L301	Same as L111
L302	Same as L111
M101	METER; 0 to 1 Ma, 1,500 ohms; Weston Meter Type No. 267; Stoddart No. 18541
M102	METER; 0 to 100 ua Stoddart No. 18543
M103	METER; 1 Ma, 12 to 17 v Scale; Stoddart No. 18542
Q101	TRANSISTOR; No. 2N502A; Stoddart No. 2N502A
Q102	Same as Q101

SYMBOL	DESCRIPTION
Q103	Same as Q101
Q104	Same as Q101
Q105	TRANSISTOR; Type No. 2N274, Stoddart No. 2N274
Q106	TRANSISTOR; Type No. 2N384; Stoddart No. 2N384
Q107	Same as Q106
Q108	Same as Q106
Q109	Same as Q105
Q110	TRANSISTOR; Type 2N1309 Stoddart No. 2N1309
Q111	Same as Q110
Q112	Same as Q110
Q113	Same as Q106
Q114 thru Q117	Not used
Q118	TRANSISTOR; Type No. 2N217; Stoddart No. 2N217
Q119	Same as Q118
Q120	Same as Q118
Q121	Same as Q118
Q122	TRANSISTOR; Type No. 2N647; Stoddart No. 2N647
Q123	TRANSISTOR; Type No. 2N835; Stoddart No. 2N835
Q124	Same as Q123

SYMBOL	DESCRIPTION
Q125 thru Q134	Not used
Q135	Same as Q118
Q136	Same as Q118
Q137	TRANSISTOR; Field Effect; Crystalonics, Inc. No. C682; Stoddart No. 18523
Q138	TRANSISTOR; Type 2N3250 Stoddart No. 2N3250
Q139	Same as Q122
Q140	Not used
Q201	TRANSISTOR; Type 2N2552; Stoddart No. 2N8552
Q202	Same as Q201
Q203	Same as Q201
Q204	TRANSISTOR, Type 2N1711; Stoddart No. 2N1711
R101	RESISTOR, FIXED, COMPOSITION; 8,200 ohms; $\pm$5%; 1/4 w; Allen Bradley Type CB-8225; Stoddart No. 11693-822
R102	Same as R101
R103	RESISTOR, FIXED, COMPOSITION; 220,000 ohms; $\pm$5%; 1/4 w; Allen Bradley Type CB-2245; Stoddart No. 11693-224
R104	Same as R103
R105	RESISTOR, FIXED, COMPOSITION; 27,000 ohms; $\pm$5%; 1/4 w; Allen Bradley Type CB-2735; Stoddart No. 11693-273

SYMBOL	DESCRIPTION
R106	RESISTOR, FIXED, FILM; 33,000 ohms; $\pm$5%; 1/4 w; Allen Bradley Type CB-3335; Stoddart No. 11693-333
R107	RESISTOR, FIXED, COMPOSITION; 2.2 Megohms; $\pm$5%; 1/4 w; Allen Bradley Type CB-2255; Stoddart No. 11693-225
R108	RESISTOR, FIXED, FILM; 10,000 ohms; $\pm$5%; 1/4 w; Allen Bradley Type CB-1035 Stoddart No. 11693-103
R109	RESISTOR, FIXED, FILM; 46.5 ohms; $\pm$5%; 1/8 w; Penn Resistor Corporation, FCAD5; Stoddart No. 11749-46R5
R110	RESISTOR, FIXED, FILM; 219 ohms; $\pm$1%; 1/8 w; Penn Resistor Corp., Type FCAD5; Stoddart No. 11749-219
R111	RESISTOR, FIXED, FILM; 63.1 ohms; $\pm$1%; 1/8 w; Penn Resistor Corp. Type FCAD5; Stoddart No. 11749-63R1
R112	RESISTOR, FIXED, COMPOSITION; 18 ohms; $\pm$5%; 1/2 w; Allen Bradley Type EB-1805; Stoddart No. 10011-180
R113	RESISTOR, FIXED, COMPOSITION; 270 ohms; $\pm$5%; 1/4 w; Allen Bradley Type CB-2715; Stoddart No. 11693-271
R114	Same as R113
R115	Same as R113

SYMBOL	DESCRIPTION
R116	RESISTOR, FIXED, COMPOSITION; 56,000 ohms; $\pm$5%; 1/4 w; Allen Bradley Type CB-5635; Stoddart No. 11693-563
R117	Same as R113
R118	Same as R116
R119	RESISTOR, FIXED, COMPOSITION; 2,200 ohms; $\pm$5%; 1/4 w; Allen Bradley Type CB-2225; Stoddart No. 11693-222
R120	RESISTOR, FIXED, COMPOSITION; 100,000 ohms; $\pm$5%; 1/4 w; Allen Bradley Type CB-1045; Stoddart No. 11693-104
R121	RESISTOR, FIXED, COMPOSITION; 470 ohms; $\pm$5%; 1/4w; Allen Bradley Type CB-4715; Stoddart No. 11693-471
R122	RESISTOR, FIXED, COMPOSITION; 22,000 ohms; $\pm$5%; 1/4 w; Allen Bradley Type CB-2235; Stoddart No. 11693-223
R123	Same as R121
R124	RESISTOR, FIXED, COMPOSITION; 150 ohms; $\pm$5%; 1/4 w; Allen Bradley Type CB-1515; Stoddart No. 11693-151
R125	RESISTOR, FIXED, COMPOSITION; 1,000 ohms; $\pm$5%; 1/4 w; Allen Bradley Type CB-1025; Stoddart No. 11693-102

SYMBOL	DESCRIPTION
R126	RESISTOR, FIXED, COMPOSITION 47,000 ohms; ±5%; 1/4 w; Allen Bradley Type CB-4735; Stoddart No. 11693-473
R127	RESISTOR, FIXED, COMPOSITION; 220 ohms; ±5%; 1/4 w; Allen Bradley Type CB-2215; Stoddart No. 11693-221
R128	Same as R125
R129	Same as R126
R130	Same as R126
R131	Same as R126
R132	RESISTOR, FIXED, COMPOSITION; 270,000 ohms; ±5%; 1/4 w; Allen Bradley Type CB-2745; Stoddart No. 11693-274
R133	RESISTOR, FIXED, COMPOSITION; 68,000 ohms; ±5%; 1/4 w; Allen Bradley Type CB-6835; Stoddart No. 11693-683
R134	Same as R116
R135	RESISTOR, FIXED, COMPOSITION; 150,000 ohms; ±5%; 1/4 w; Allen Bradley Type CB-1545; Stoddart No. 11693-154
R136	RESISTOR, FIXED, COMPOSITION; 39,000 ohms; ±5%; 1/4 w; Allen Bradley Type CB-3935; Stoddart No. 11693-393
R137	RESISTOR, FIXED, COMPOSITION; 15,000 ohms; ±5%; 1/4 w; Allen Bradley Type CB-1535 Stoddart No. 11693-153
R138	RESISTOR, FIXED, COMPOSITION; 82,000 ohms; ±5%; 1/4 w; Allen Bradley Type CB-8235; Stoddart No. 11693-823
R139	Same as R125
R140	Same as R122
R141	RESISTOR, FIXED, COMPOSITION; 18,000 ohms; ±5%; 1/4 w; Allen Bradley Type CB-1835; Stoddart No. 11693-183
R142	Same as R122
R143	RESISTOR, FIXED, COMPOSITION; 1.8 K ohms; ±5%; 1/4 w; Allen Bradley Type CB-1825; Stoddart No. 11693-182
R144	Same as R112
R145	RESISTOR, FIXED, COMPOSITION; 10,000 ohms; ±5%; 1/4 w; Allen Bradley Type CB-1035; Stoddart No. 11693-103
R146	RESISTOR, FIXED, COMPOSITION; 12,000 ohms; ±5%; 1/4 w; Allen Bradley Type CB-1235; Stoddart No. 11693-123
R147	RESISTOR, FIXED, COMPOSITION; 1,200 ohms; ±5%; 1/4 w; Allen Bradley Type CB-1225; Stoddart No. 11693-122
R148	Not used
R149	RESISTOR, FIXED, COMPOSITION; 6,800 ohms; ±5%; 1/4 w; Allen Bradley Type CB-6825; Stoddart No. 11693-682

SYMBOL	DESCRIPTION
R150	Same as R113
R151	RESISTOR, FIXED, COMPOSITION; 120,000 ohms; ±5%; 1/4 w; Allen Bradley Type CB-1245; Stoddart No. 11693-124
R152	Same as R151
R153	RESISTOR, FIXED, COMPOSITION; 330 ohms; ±5%; 1/4 w; Allen Bradley Type CB-3315; Stoddart No. 11693-331
R154	Same as R138
R155	Same as R136
R156	Same as R153
R157	Same as R138
R158	Same as R136
R159	RESISTOR, FIXED, COMPOSITION; 68 ohms; ±5%; 1/4 w; Allen Bradley Type CB-6805; Stoddart No. 11693-680
R160	RESISTOR, FIXED, COMPOSITION; 2,700 ohms; ±5%; 1/4 w; Allen Bradley Type CB-2725; Stoddart No. 11693-272
R161	Same as R138
R162	RESISTOR, FIXED, COMPOSITION; 470,000 ohms; 1/4 w; ±5%; Allen Bradley Type CB-4745; Stoddart No. 11693-474
R163	Same as R106
R164	Same as R103

SYMBOL	DESCRIPTION
R165	RESISTOR, FIXED, COMPOSITION; 22 ohms; ±5%; 1/4 w; Allen Bradley Type CB-2205; Stoddart No. 11693-220
R166	RESISTOR, FIXED, FILM; 50 ohms; ±1%; 1/2 w; Penn Resistor Corp., FCA15; Stoddart No. 10935-50R0
R167	Same as R166
R168A,B	RESISTOR, VARIABLE; Two section Composition Element; Back Section 1,000 ohms; Front Section 500 ohms; Allen Bradley Type B1021, A5011; Stoddart No. 11362
R169	RESISTOR, FIXED, FILM; 62.0 ohms; ±1%; 1/2 w; Penn Resistor Corp., FCA15; Stoddart No. 10935-62R0
R170	RESISTOR, FIXED, FILM; 249 ohms; ±1%; 1/2 w; Penn Resistor Corp., FCA15; Stoddart No. 10935-2490
R171	Same as R169
R172	Same as R160
R173	Same as R136
R174	Same as R120
R175	Same as R160
R176	Same as R138
R177	Same as R127
R178	RESISTOR, FIXED, COMPOSITION; 22 ohms; ±5%; 1/4 w; Allen Bradley Type CB-2205; Stoddart No. 11693-220

SYMBOL	DESCRIPTION
R179	Same as R138
R180	Same as R136
R181	RESISTOR, FIXED, COMPOSITION; 3,300 ohms; ±5%; 1/4 w; Allen Bradley Type CB-3325; Stoddart No. 11693-332
R182	Not used
R183	RESISTOR, FIXED, COMPOSITION; 1,500 ohms; ±5%; 14/ w; Allen Bradley Type CB-1525; Stoddart No. 11693-152
R184	RESISTOR, FIXED, COMPOSITION; 15,000 ohms; ±5%; 1/4 w; Allen Bradley Type CB-1535; Stoddart No. 11693-153
R185	RESISTOR, FIXED, COMPOSITION; 100 ohms; ±5%; 1/4 w; Allen Bradley Type CB-1015; Stoddart No. 11693-101
R186	RESISTOR, FIXED, COMPOSITION; 10 ohms; ±5%; 1/4 w; Allen Bradley Type CB-1005; Stoddart No. 11693-100
R187	RESISTOR, VARIABLE; 10,000 ohms; ±5%; 1 w; Helipot Model 62-103; Stoddart No. 18546-103
R188	Same as R136
R189	Same as R138
R190	Same as R138

SYMBOL	DESCRIPTION
R191	RESISTOR, FIXED, COMPOSITION; 39 ohms; ±5%; 1/4 w; Allen Bradley Type CB-3905; Stoddart No. 11693-390
R192	Same as R151
R193	RESISTOR, FIXED, COMPOSITION; 10,000 ohms; ±5%; 1/4 w; Allen Bradley Type CB-1035; Stoddart No. 11693-103
R194	RESISTOR, FIXED, COMPOSITION; 47,000 ohms; ±5%; 1/4 w; Allen Bradley Type CB-4735; Stoddart No. 11693-473
R195	Same as R138
R196	Same as R136
R197	Same as R181
R198	Same as R106
R199	Same as R112
R200	Same as R120
R201	RESISTOR, FIXED, COMPOSITION; 470,000 ohms; ±5%; 1/4 w; Allen Bradley Type CB-4745; Stoddart No. 11693-474
R202	Same as R103
R203	RESISTOR, VARIABLE, COMPOSITION; 25,000 ohms; ±10%; 2 w; Allen Bradley Type J, CU2531; Stoddart No. 11733
R204	Same as R178
R205	Same as R201

SYMBOL	DESCRIPTION
R206	RESISTOR, VARIABLE; wirewound, 1 Megohm; Bourns Trimpot, 276-1-105 Stoddart No. 18510-105
R207	Same as R206
R208	Same as R201
R209	RESISTOR, FIXED, COMPOSITION; 6.8 Megohm; $\pm$5%; 1/4 w; Allen Bradley Type CB-6855; Stoddart No. 11693-685
R210	RESISTOR, VARIABLE; wirewound, 10,000 ohms; Bourns Trimpot, 275-1-103, Stoddart No. 18510-103
R211	Same as R210
R212	Same as R210
R213	Not used
R214	Same as R137
R215	Same as R210
R216	Same as R137
R217	Same as R210
R218	RESISTOR, VARIABLE; wirewound, 20,000 ohms; Bourns Trimpot, 275-1-203, Stoddart No. 18510-203
R219	RESISTOR, FIXED, COMPOSITION; 4,700 ohms; $\pm$5%; 1/4 w; Allen Bradley Type CB-4725; Stoddart No. 11693-472
R220	Same as R136
R221	Same as R183

SYMBOL	DESCRIPTION
R222	RESISTOR, FIXED, COMPOSITION; 3,900 ohms; $\pm$5%; 1/4 w; Allen Bradley Type CB-3925; Stoddart No. 11693-392
R223	RESISTOR, FIXED, COMPOSITION; 5,100 ohms; $\pm$5%; 1/4 w; Allen Bradley Type CB-5125; Stoddart No. 11693-512
R224	Not used
R225	RESISTOR, FIXED, COMPOSITION; 750 ohms; $\pm$5%; 1/4 w; Allen Bradley Type CB-7515; Stoddart No. 11693-751
R226	RESISTOR, VARIABLE; wirewound, 5,000 ohms, Bourns Trimpot, 275-1-502, Stoddart No. 18510-502
R227	Same as R125
R228	Same as R120
R229	Same as R116
R230	Same as R122
R231	Same as R151
R232	Same as R125
R233	Same as R101
R234	RESISTOR, FIXED, COMPOSITION; 5,600 ohms; $\pm$5%; 1/4 w; Allen Bradley Type CB-5625; Stoddart No. 11693-562
R235	Same as R103
R236	Same as R120
R237	Same as R193

SYMBOL	DESCRIPTION
R238	RESISTOR, FIXED, COMPOSITION; 620 ohms; ±5%; 1/4 w; Allen Bradley Type CB-6215; Stoddart No. 11693-621
R239	RESISTOR, VARIABLE; 100 ohms; Helipot No. 7221-R1K1-25 Stoddart No. 18515-101
R240	RESISTOR, FIXED, CARBON, FILM; 1,540 ohms; Penn Resistor Corp. FCA10; Stoddart No. 18548-1540R
R241	RESISTOR, VARIABLE, COMPOSITION; 100,000 ohms; ±10%; 2 w; Allen Bradley Type JA1N056P104AA; Stoddart No. 11741
R242	Same as R116
R243	Same as R103
R244	Same as R122
R245	Same as R125
R246	Same as R101
R247	Same as R103
R248	Same as R151
R249	Same as R137
R250	Same as R125
R251	Same as R125
R252	Same as R125
R253	Same as R126
R254	Same as R116
R255	Same as R178
R256	Same as R178

SYMBOL	DESCRIPTION
R257	Same as R127
R258	Same as R103
R259	Same as R119
R260	Same as R160
R261	Same as R160
R262	Same as R160
R263	Same as R143
R264	Same as R143
R265	Same as R143
R266	Same as R122
R267	Same as R125
R268	Same as R138
R269	RESISTOR, FIXED; (Selected Value)
R270	Same as R132
R271 thru R278	Not used
R279	Same as R132
R280	Same as R101
R281 thru R291	Not used
R299	Same as R119
R300	Not used
R301	Not used
R302	RESISTOR, FIXED, COMPOSITION; (Selected 1/4 w)

SYMBOL	DESCRIPTION
R303	Same as R119
R304	RESISTOR, FIXED, COMPOSITION; 820 ohms; ±5%; 1/4 w; Allen Bradley Type CB8215; Stoddart No. 11693-821
R305	Same as R121
R306	RESISTOR, FIXED, COMPOSITION; 7,500 ohms; ±5%; 1/4 w; Allen Bradley Type CB-7525; Stoddart No. 11693-752
R307	Same as R304
R308	RESISTOR, FIXED, COMPOSITION; 1,200 ohms; ±5%; 1/4 w; Allen Bradley Type CB-1225; Stoddart No. 11693-122
R309	RESISTOR, FIXED, COMPOSITION; 470 ohms; ±5%; 1/4 w; Allen Bradley Type CB-4715; Stoddart No. 11693-471
R310	RESISTOR, FIXED, COMPOSITION; 390 ohms; ±5%; 1/4 w; Allen Bradley Type CB-3915 Stoddart No. 11693-391
R311	Same as R310
R312	RESISTOR, FIXED, COMPOSITION; 150 ohms; ±5%; 1/4 w; Allen Bradley Type CB-1515; Stoddart No. 11693-151
R313	RESISTOR, VARIABLE, WIREWOUND; 1,000 ohms; Helipot 7221-R1KL-25 Stoddart No. 18515
R314	RESISTOR, FIXED, COMPOSITION; 22 ohms; ±5%; 2 w; Allen Bradley Type HB-2205; Stoddart No. 10377-220
R315	RESISTOR, FIXED, COMPOSITION; 2,700 ohms; ±5%; 1/2 w; Allen Bradley Type EB-2725; Stoddart No. 10011-272
R316	RESISTOR, FIXED, COMPOSITION; 100 ohms; ±5%; 2 w; Allen Bradley Type HB-1015; SToddart No. 10377-101
R317	RESISTOR, FIXED, COMPOSITION; 33 ohms; ±5%; 1/4 w; Allen Bradley Type CB-3305; Stoddart No. 11693-330
R318	RESISTOR, VARIABLE; 200 ohms; Bourns Trimpot No. 275-1-201 Stoddart No. 18510-201
R319	Same as R201
R320	RESISTOR, FIXED, COMPOSITION; 4,700 ohms; ±5%; 1/4 w; Allen Bradley Type CB-4725; Stoddart No. 11693-472
R321	Same as R151
R322	Same as R147
R323	Same as R119
R324	RESISTOR, VARIABLE; 500 ohms; Bourns Trimpot; 275-1-501; Stoddart No.18510-501
R325	Same as R181

SYMBOL	DESCRIPTION
RT101	RESISTOR, THERMAL; 10,000 ohms; G.E. No. D101; Stoddart No. 11563
RT103	RESISTOR, THERMAL; 750 ohms; VECO, Type No. 28D13; Stoddart No. 18614
S101A, B, C	SWITCH, Slide; Single Double, conversion switch, Stoddart No. 18531
S102A,B	SWITCH, Push; Single Pole; Double Throw; Microswitch Co., No. 11SM23; Stoddart No. 18536
S103A thru H	SWITCH, ROTARY; wafer switch sections; Stoddart No. 11756A
S104	Not used
S105	SWITCH, TOGGLE; SPDT; C & K Components; Type 7101; Stoddart No. 18544
S106A,B	Same as S102
S107	SWITCH, SENSITIVE; SPDT, Mercury Wetted Contacts; C. P. Clare, HGS-5,000; Stoddart No. 11562
S108	SWITCH, ROTARY, Four Pole, Three Position; Stoddart No. 18324
S109	Same as S105
S301	Not used
S302	SWITCH, TOGGLE, DPDT; Arrowhart and H. No. 83054 Stoddart No. 10172

SYMBOL	DESCRIPTION
T101	TRANSFORMER, RADIO FREQUENCY; RF Input Coil; p/o No. Z104; Stoddart No. 93864-1
T102	TRANSFORMER, RADIO FREQUENCY; RF Coil, p/o Z104; Stoddart No. 93866-1
T103	TRANSFORMER, RADIO FREQUENCY; RF Oscillator Coil; p/o Z104; Stoddart No. 93867-1
T104	TRANSFORMER, RADIO FREQUENCY; RF Input Coil, p/o Z105; Stoddart No. 93869-1
T105	TRANSFORMER, RADIO FREQUENCY; RF Coil; p/o Z105; Stoddart No. 93871-1
T106	TRANSFORMER, RADIO FREQUENCY; Oscillator Coil; p/o Z105; Stoddart No. 93872-1
T107	TRANSFORMER, RADIO FREQUENCY; RF Input Coil; p/o Z106; Stoddart No. 93874-1
T108	TRANSFORMER, RADIO FREQUENCY; RF Coil; p/o Z106; CADV; Stoddart No. 93875-1
T109	TRANSFORMER, RADIO FREQUENCY; RF Mixer Stage, p/o Z106; CADV; Stoddart No. 93876-1
T110	TRANSFORMER, RADIO FREQUENCY; Oscillator Coil; p/o Z106; Stoddart No. 93877-1
T111	TRANSFORMER, RADIO FREQUENCY; RF Input Coil; p/o Z107; Stoddart No. 93880-1

SYMBOL	DESCRIPTION
T112	TRANSFORMER, RADIO FREQUENCY; RF Coil; p/o Z107; CADV Stoddart No. 93881-1
T113	TRANSFORMER, RADIO FREQUENCY; RF Mixer Stage; p/o Z107; CADV Stoddart No. 93882-1
T114	TRANSFORMER, RADIO FREQUENCY; Oscillator Coil; p/o Z107; Stoddart No. 93883-1
T115	TRANSFORMER, RADIO FREQUENCY; RF Input Coil; p/o Z108; Stoddart No. 93885-1
T116	TRANSFORMER, RADIO FREQUENCY; RF Coil; p/o Z108 Stoddart No. 93886-1
T117	TRANSFORMER, RADIO FREQUENCY; RF Mixer Stage; p/o Z108 Stoddart No. 93887-1
T118	TRANSFORMER, RADIO FREQUENCY; RF Oscillator Coil; p/o Z108; Stoddart No. 93888-1
T119	TRANSFORMER, RADIO FREQUENCY; RF Input Coil; p/o Z109; Stoddart No. 93890-1
T120	TRANSFORMER, RADIO FREQUENCY; RF Coil; p/o Z109; Stoddart No. 93891-1
T121	TRANSFORMER, RADIO FREQUENCY; RF Mixer Stage, p/o Z109; Stoddart No. 93892-1
T122	Transformer, RADIO FREQUENCY; Oscillator Coil; p/o Z109; Stoddart No. 93893-1

	DESCRIPTION
T123	TRANSFORMER, RADIO FREQUENCY; RF Input Coil; p/o Z110; Stoddart No. 93895-1
T124	TRANSFORMER, RADIO FREQUENCY; RF Coil; p/o Z110; Stoddart No. 93896-1
T125	TRANSFORMER, RADIO FREQUENCY; RF Mixer Stage; p/o Z110; Stoddart No. 93897-1
T126	TRANSFORMER, RADIO FREQUENCY; Oscillator Coil, p/o Z110; Stoddart No. 93898-1
T127	TRANSFORMER, RADIO FREQUENCY; RF Input Coil, p/o Z111; Stoddart No. 93901-1
T128	TRANSFORMER, RADIO FREQUENCY; RF Coil; p/o Z111; Stoddart No. 93902-1
T129	TRANSFORMER, RADIO FREQUENCY; RF Mixer Stage; p/o Z111; Stoddart No. 93903-1
T130	TRANSFORMER, RADIO FREQUENCY; Oscillator Coil, p/o Z111; Stoddart No. 93904-1
T131 thru T132	Not used
T133	TRANSFORMER, INTERMEDIATE FREQUENCY; Stoddart No. 93949-1
T134	TRANSFORMER, INTERMEDIATE FREQUENCY; Stoddart No. 93950-1

SYMBOL	DESCRIPTION
T135	TRANSFORMER, INTERMEDIATE FREQUENCY; Primary; Stoddart No. 93951-1
T136	TRANSFORMER, INTERMEDIATE FREQUENCY; Stoddart No. 93952-1
T137	TRANSFORMER, RADIO FREQUENCY; Stoddart No. 93953-1
T138	TRANSFORMER, INTERMEDIATE FREQUENCY; Stoddart No. 93954-1
T139	TRANSFORMER, INTERMEDIATE FREQUENCY; Stoddart No. 93955-1
T140	TRANSFORMER, INTERMEDIATE FREQUENCY; Stoddart No. 93956-1
T141	TRANSFORMER, INTERMEDIATE FREQUENCY; Stoddart No. 93957-1
T142	TRANSFORMER, INTERMEDIATE FREQUENCY: Stoddart No. 93958-1
T143	TRANSFORMER, INTERMEDIATE FREQUENCY; Stoddart No. 93959-1
T144	TRANSFORMER, INTERMEDIATE FREQUENCY; Stoddart No. 93960-1
T145	TRANSFORMER, RADIO FREQUENCY; Primary; Stoddart No. 93961-1
T146	TRANSFORMER, RADIO FREQUENCY; Stoddart No. 93931-1
T147	TRANSFORMER, RADIO FREQUENCY; Stoddart No. 93263-1
T301	Not used
T302	TRANSFORMER, POWER; Primary; 115 v - 220 v; Shielded; 25.5 Secondary; Axtec No. 2605; Stoddart No. 18513

RADIATION HAZARDS
IN RADIO INTERFERENCE MEASUREMENT

1. Biological damage from exposure to intense RF radiation has been known for several years but only recently have quantitative limits been established.

2. A tri-service limit for exposure to RF radiation has been established at .01 watts/cm^2 at any frequency. This is 194 volts/meter assuming linearly polarized plane waves. General Electric has proposed that a maximum safe limit of .001 watts/cm^2 (61 volts/meter) be used for continuous exposure and that .01 watts/cm^2 be an absolute maximum not to be exceeded except under emergency conditions.

3. It is possible that personnel operating Stoddart equipment will be exposed to power densities greater than .01 watts/cm^2. This will probably occur in locations where the rf field will not be linearly polarized plane waves such as the Fresnel Zone and in close proximity to magnetrons and klystrons.

4. It is suggested that before taking measurements near suspected or known strong radiation sources that reliable information on intensity be obtained.

Direct measurements of strong signal sources can be made with RI-FI equipment if the frequency is in the tuning range. Most RI-FI equipment does not have sufficient voltage range or shielding effectiveness to accurately measure to 194 volts/meter using standard antennas. In some situations, involving concentrated fields, the use of loop probes with their large antenna factors would enable approximate measurement. Limitations in RI-FI equipment shielding sometimes permits full scale meter indication when tuned to a very strong signal even with the antenna disconnected. Needless to say, the operator should be concerned when this occurs.

The following chart provides approximate equipment range limits (full scale) in volts/meter with and without pickup devices.

The equipment would be standardized for gain in accordance with instructions on the charts supplied. Then the input attenuator should be placed in the maximum position. Continuous wave signals would be measured in FI function switch position. Pulsed signals are measured with PEAK function.

STODDART NO. 40019-A

Equipment	Antenna	Approximate field strength volts/meter Equivalent radiation levels given in table below
NM-10A	Half meter rod	2
	30" loop (90117-2)	10
(14 kc to 250 kc)	6" loop (90114-2)	100
	Loop probe (90185-1)	1000*
	No antenna (or cable)	100 to 200
NM-20B	41" rod (90291-2)	2
	Loop antenna (90298-2)	.1
(150 kc to 25 mc)	Loop probe (90185-2)	10*
	No antenna (or cable)	20
NM-30A	Tuned dipole	1 to 50
	Loop antenna (90799-2)	170 to 500*
(20 mc to 400 mc)	No antenna (or cable)	10 to 500
NM-50	Tuned dipole	30 to 180
(375 mc to 1000 mc)	No antenna (or cable)	100 to 180

Field Strength volts/meter	Radiation Level watts/cm^2
0.1	0.265×10^{-8}
2.0	1.06×10^{-6}
10.	0.265×10^{-4}
20	1.06×10^{-4}
30	2.39×10^{-4}
50	6.63×10^{-4}
100	0.265×10^{-2}
170	0.766×10^{-2}
180	0.86×10^{-2}
200	1.06×10^{-2}
500	6.63×10^{-2}
1000	0.265

$$P = \frac{(E)^2}{120\pi} = .00265(E)^2 \frac{\text{watts}}{(\text{meter})^2}$$

P = Radiation Level

E = Field Strength - $\frac{\text{volts}}{\text{meter}}$

$$P \frac{(\text{watts})}{\text{cm}^2} = 10^{-4} \times P \frac{(\text{watts})}{(\text{meter})^2}$$

* Maximum measurement shown using loop probe antenna is only practical if RI-FI equipment is not exposed to strong RF field.

ENGINEERING DEPARTMENT
October 27, 1965

STODDART ELECTRO SYSTEMS
2045 West Rosecrans Avenue
Gardena, California 90249

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STODDART NO. 40019-A

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NM-10A	Half meter rod	2
	30" loop (90117-2)	10
(14 kc to 250 kc)	6" loop (90114-2)	100
	Loop probe (90185-1)	1000*
	No antenna (or cable)	100 to 200
NM-20B	41" rod (90291-2)	2
	Loop antenna (90298-2)	.1
(150 kc to 25 mc)	Loop probe (90185-2)	10*
	No antenna (or cable)	20
NM-30A	Tuned dipole	1 to 50
	Loop antenna (90799-2)	170 to 500*
(20 mc to 400 mc)	No antenna (or cable)	10 to 500
NM-50	Tuned dipole	30 to 180
(375 mc to 1000 mc)	No antenna (or cable)	100 to 180

Field Strength volts/meter	Radiation Level watts/cm^2
0.1	0.265×10^{-8}
2.0	1.06×10^{-6}
10.	0.265×10^{-4}
20	1.06×10^{-4}
30	2.39×10^{-4}
50	6.63×10^{-4}
100	0.265×10^{-2}
170	0.766×10^{-2}
180	0.86×10^{-2}
200	1.06×10^{-2}
500	6.63×10^{-2}
1000	0.265

$$P = \frac{(E)^2}{120\pi} = .00265(E)^2 \frac{\text{watts}}{(\text{meter})^2}$$

P = Radiation Level

E = Field Strength - $\frac{\text{volts}}{\text{meter}}$

$$P\ \frac{(\text{watts})}{\text{cm}^2} = 10^{-4} \times P\ \frac{(\text{watts})}{(\text{meter})^2}$$

* Maximum measurement shown using loop probe antenna is only practical if RI-FI equipment is not exposed to strong RF field.

ENGINEERING DEPARTMENT
October 27, 1965

STODDART ELECTRO SYSTEMS
2045 West Rosecrans Avenue
Gardena, California 90249

Warranty

Stoddart Electro Systems warrants each RFI Meter manufactured by them to be free from defects in workmanship and material. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replace any defective parts thereof. Klystron tubes, electron tubes, fuses and batteries are specifically excluded from any liability.

This warranty is effective for one year after delivery to the original purchaser. If the fault has been caused by misuse or mishandling, repairs will be billed to the purchaser. In this case, an estimate will be submitted before the work is begun.

In the event that any defect occurs, Stoddart Electro Systems should be advised of all details and the model and serial number of the equipment. Shipping instructions and service data will be provided. To ensure safe handling, all equipment should be forwarded with protective covers in place and in strong exterior containers surrounded by several inches of rubberized hair or similar shock-absorbing material to the factory or authorized repair station via scheduled Air Freight.

CLAIM FOR DAMAGE IN TRANSIT

Equipment should be tested as soon as it is received. If it fails to operate properly, or is damaged in any manner, a claim should be filed with the transportation company. A report of the damage should be obtained by the claim agent, and this report forwarded to Stoddart Electro Systems with model and serial number of the equipment. Advice regarding repair or replacement will be supplied immediately upon receipt of this information

STODDART ELECTRO SYSTEMS
(Division of Tamar Electronics, Inc.)
2045 West Rosecrans Ave., Gardena, California 90247